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THE
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NEW SERIES. DECADE II. VOL. I.

No. I.—JANUARY, 1874.

ORIGINAL ARTICLES.

I.—MICROSCOPIC STRUCTURE OF IRISH GRANITES.

No. 2. GRANITE OF AILLEMORE, CO. MAYO.

By Prof. EDWARD HULL, M.A., F.R.S., President R.G.S.I.

(PLATE I.)

lead before the Royal Geological Society of Ireland, 11th November, 1873.]

IIS granite forms an isolated mass, rising into two eminences a few miles south of Louisburg, called Corvock Brack (1287 feet) Knockaskeheen (1288 feet). It is a greyish granite—generally grained—consisting of quartz, two felspars,—one orthoclase, the : triclinic, probably oligoclase—and dark green mica. In some s there are patches in which the felspar assumes the appearance graphic granite." Numerous boulders of this granite are strewn the district to the north-west, and on the south side of Knock- ieen; the rock is traversed by regular joints ranging N. 10 W., ; which it splits off into nearly vertical walls. The position of ranite is shown on Griffith's Geological Map of Ireland, and it rrounded by schistose beds, generally metamorphosed, and pro- of Lower Silurian age. The granite itself is of older date than pper Llandovery beds, which lie to the southward.

croscopic Slice.—The thin slice prepared by Mr. Jordan, of the ig Record Office in London, shows the general structure of ranite extremely well. With the 2-inch object-glass, and under ized light, its constituents are brought out in their relative rtions; the most abundant mineral being orthoclase, next silica, the triclinic felspar, then mica, and lastly magnetite. I shall lescribe these minerals in the order above stated.

thoclase.—In the section this felspar is often clouded and ureless, but is occasionally crystallized out into nearly perfect ls, in which the angle of 90° between the sides may be ently observed. But besides these there are several examples e "cross-banded" felspar, similar to that described and figured y paper on the granite of Firbogh. These come out under zed light, the bands crossing each other at angles approaching In one or two instances the banding takes a wavy form, and ly in one direction (Fig. 4). These various forms of this ar structure I regard as being characteristic of orthoclase, and wed in my former paper on the Firbogh granite that they due *to a cellular structure along* planes crossing each other [illegible] planes of cleavage. The [illegible] same cause: but the [illegible] well defined as in the

[illegible] parallel lines charac- [illegible] several instances, [illegible] The crystals however, [illegible] well defined as in [illegible] there is no crystalline [illegible] grain. An [illegible] Fig. [illegible] It is slightly

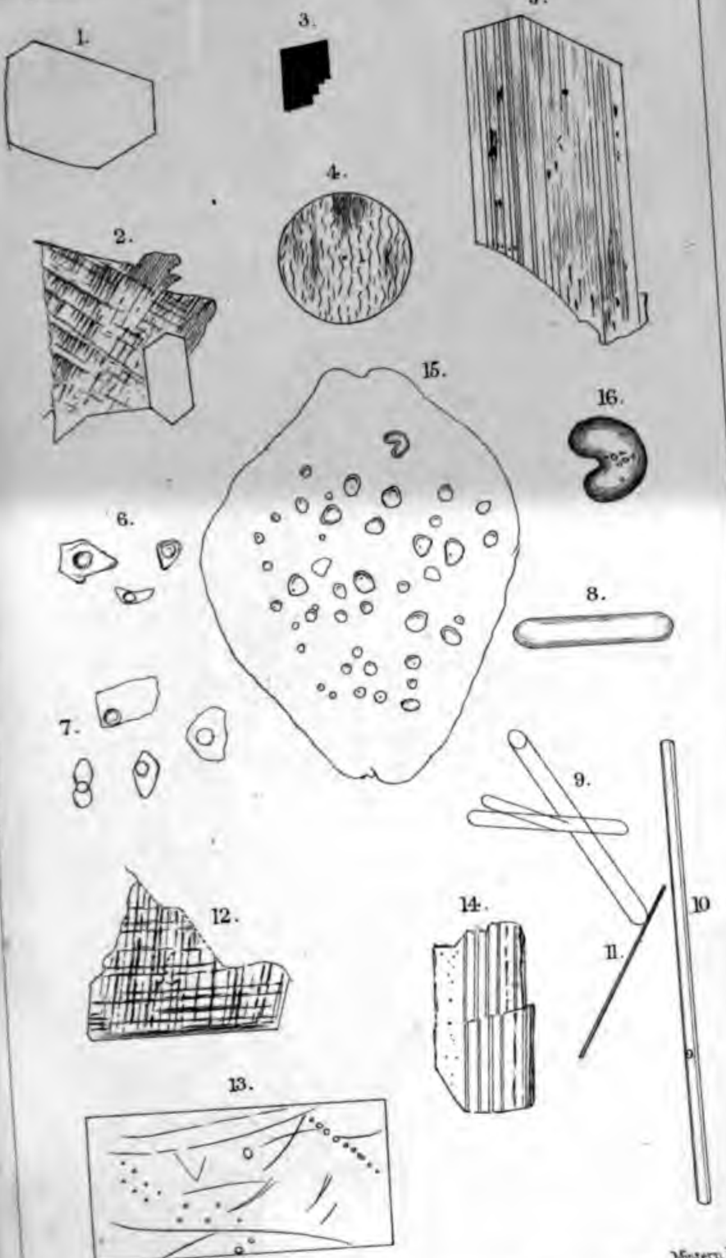
[illegible] the basis in which [illegible] It is itself with- [illegible] it by the sides [illegible] edges [illegible] different prismatic [illegible] the analyzer, the [illegible] sometimes imper- [illegible] view, like the

[illegible] cellular, [illegible] With the [illegible] are wel [illegible] Fig. [illegible] Some [illegible] generally [illegible] the vapou [illegible] was n [illegible] this sli [illegible] grain

[illegible] of whi [illegible] the felspar.

[illegible]

[illegible] great mass of [illegible] which [illegible] considered by the Rev. Dr. [illegible] near Dublin. It has [illegible]



C. L. Griesbach.
Mintern Bros. im

Microscopic Structure of Irish Granites.
Figs. 1-6. Granite of Aillemore.
Figs. 7-16. Granite of Ballyknockan.

at various angles corresponding with the planes of cleavage. Th cases here observed are also referable to the same cause; but th cellular structure is scarcely so regular and well defined as in th case above referred to.

Triclinic Felspar (Oligoclase ?).—The fine parallel lines characteristic of the triclinic felspars are observable in several instances and are well brought out by polarized light. The crystals, however, are not nearly so numerous, nor are their forms so well defined as in the case of the orthoclase; sometimes, indeed, there is no crystalline form whatever, the felspar occurring as an amorphous grain. An unusually well-formed crystal is represented in Fig. 5. It is slightly clouded.

Silica.—The silica, as usual in granites, forms the basis in which the other minerals (felspar and mica) are imbedded. It is itself without crystalline form, receiving only the forms given to it by the sides of the felspar crystals; and with polarized light the boundary edges are often seen lined by narrow parallel bands of different prismatic colours. The interior portions exhibit, on rotating the analyzer, the usual gorgeous shades of colouring, one colour sometimes imperceptibly shading off into another over the fields of view, like the blending of the colours in a rainbow.

With the $\frac{1}{4}$-inch object-glass the silica is seen to be highly cellular and fluid bubbles in some of the cells come into view. With th No. 2 eyepiece, magnifying 350 diameters, the bubbles are we developed, and appear to occur in most of the cells (Fig. 6). Som times the cells are exceedingly irregular in form, sending out angul projections in various directions. The bubbles seem generally occupy a large proportion of the cells, about one-third or one-four of the entire space, from which it might be inferred that the vapo from the condensation of which the bubble has been formed was originally highly rarefied. Sometimes the cells occur in long sligh curved lines. Tubes and trichites are rare in the silica of this sli

Mica.—With a high magnifying power the mica has a green colo and shows a wavy structure. It sometimes incloses black grai which I have little doubt are those of magnetite.

Magnetite.—Some grains of magnetite undoubtedly occur, one which is represented in Fig. 3. They are as usual opaque, a generally imbedded in the mica flakes. A few individuals, of wh that above referred to is an example, are imbedded in the felspar.

II.—MICROSCOPIC STRUCTURE OF IRISH GRANITES.

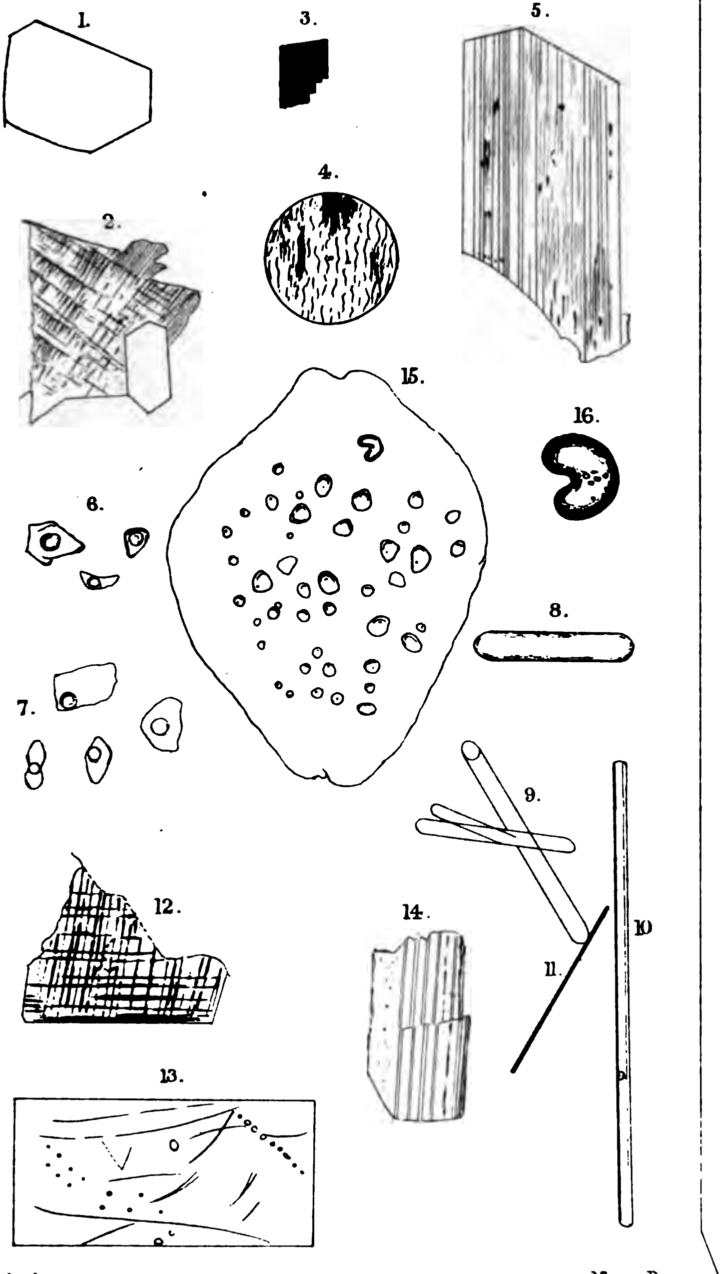
No. 3. GRANITE OF BALLYKNOCKAN, CO. WICKLOW.

By Professor EDWARD HULL, M.A., F.R.S., President R.G.S.I.

(PLATE I.)

THE granite of Ballyknockan belongs to the great mass of South-east of Ireland, which extends from Booterstown, n Dublin, to Poulmounty in Co. Carlow.

The Ballyknockan granite is considered by the Rev. Dr. Haught F.R.S., to be the best building-stone near Dublin. It has, accord



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Microscopic Structure of Irish Granites.
Figs. 1-6 Granite of Aillemore.
Figs. 7-16. Granite of Ballyknockan

to this observer, a specific gravity of 2·636, and affords the following chemical analysis.[1]

Silica	70·82
Alumina	14·08
Peroxide of iron	3·47
Lime	2·65
Magnesia	0·31
Potash	4·64
Soda	2·31
Loss by ignition	1·39
	99·67

The admirable investigations of Dr. Haughton leave little to be added in the way of analysis. Nevertheless, the microscope reveals the presence of a second variety of felspar besides the orthoclase, which he and Professor Galbraith were able alone to detect from chemical examination. This second mineral, indeed, might probably have remained unobserved, except for the introduction of this new process of investigation.[2]

The rock from which the thin slices are taken is finely crystalline granular, and consists of a siliceous paste, inclosing white felspar, silvery-grey and black mica. With polarized light the felspar is seen to consist of orthoclase, and a triclinic felspar, less abundant but well defined; and the proportions in which the minerals occur may be thus arranged:—1. Silica; 2. Orthoclase; 3. Triclinic felspar; 4. Grey mica; 5. Black mica—the last occurring of a rich bronze colour.

Silica.—The silica occurs in an amorphous state, inclosing the other minerals, as is usual in true granites; but is itself composed of numerous individual patches, each refracting the light differently, so as to represent, on rotating the analyzer, a great variety of rich colours. The individual patches are generally separated by a fringe of prismatic hues, probably due to varying thicknesses of the section at the edges.

With the ¼-inch object-glass numerous cells of varying shapes and sizes come into view, together with some wonderfully long "trichites" ("trichiten," Zirkel) (Fig. 13), some straight, others bent or curved, and stretching through the mass in various directions. They are quite distinct from the tubes, and I have no good idea regarding their nature.

The cells are often disposed in lines, or along planes, perhaps concealed cleavage-planes. The cells for the most part contain fluid bubbles (Fig. 7), but they are only visible with a very high power; some, however, are "stone-cavities."

Along with the cells and stone-cavities are also to be observed, with a high power, very remarkable straight tubes (Figs. 8, 9, 10), terminated by rounded ends, and evidently hollow, or filled with gas. One of these (Fig. 10), remarkable for its length, seems to contain a very minute bubble near the centre, and another at the end of the tube itself. When first observed, I was at a loss to account for the formation of tubes of such length, straightness, and comparative thinness; but on showing the drawing which I had made of them to Prof O'Reilly, he at once pronounced them to be "tracks of gas bubbles," passing in certain directions through the silica when in a viscous state. I have little doubt that this is the true explanation of their occurrence.

---

[1] Haughton, "*Granites of Ireland,*" *Quart.* Journ. Geol. Soc. vol. xii. p. 177.

[2] *Dr. Westropp, however, has detected a crystal* of albite in the granite belonging *to the same mass at Dalkey.* Journ. Geol. Soc. Dub. vol. ii. new ser. p. 213.

Gas cavities (?).—A remarkable constellation of cells in silica, devoid of fluid bubbles, and which were, therefore, probably filled originally with gas, is represented in Fig. 10. In outline they are irregular, and when seen under a high power the uneven form of the walls of each cell gives rise to bright points, shading off laterally. When the light from the reflecter is allowed to pass through the lower prism, the sides are seen to shade off internally in a series of faint but delicately defined concentric rings of prismatic colours, which art would fail to represent.

Orthoclase.—The orthoclase occurs generally in formless patches or in sub-crystalline forms, displaying with polarized light the "cross-banded" structure, very strongly pronounced (Fig. 12); the bands of colour intersecting at angles approaching 90°. This structure I have shown in a former paper to be due to planes of cells, corresponding with those of cleavage, intersecting each other at certain angles.[1]

Triclinic Felspar.—Judging from the analysis of Dr. Haughton, and the actual determination of the presence of albite in the granit of Dalkey by Dr. Westropp, which is part of the same mass, I hav little hesitation in identifying the triclinic felspar which occurs i the Ballyknockan granite with albite. There are several small sub-crystalline forms in the slices, exhibiting with polarized light th fine parallel lines, and bands by which the anorthic group of felspar may be distinguished; one of them is represented in Fig. 14.

Mica.—The silvery-grey mica occurs in the slice almost colourles to pale brown; the black mica as a deep bronze. The former, wit a moderate power, is seen to be traversed by fine parallel line indicating the planes of cleavage. The bronze mica with polarize light changes to black when the prisms are crossed; the colourles mica shows a rather faint play of colours on rotating the prisms.

In fine—the most noticeable features in the structure of this granit are the occurrence of a triclinic felspar, and the remarkable varietie of cellular structure in the silica.

EXPLANATION OF PLATE I.

FIG. 1. Cross-section of felspar crystal. Granite of Aillemore.
,, 2. Portion of crystalline grain of orthoclase, showing "cross-banded" structure Magnified 25 diameters. Granite of Aillemore.
,, 4. Portion of orthoclase crystal, showing wavy-banded structure. Magnifie 25 diameters. Granite of Aillemore.
,, 5. Imperfect crystal of triclinic felspar (oligoclase ?), showing fine parallel lines Magnified 150 diameters. Granite of Aillemore.
,, 6. Cells in silica containing fluid bubbles. Magnified 400 diameters. Granit of Aillemore.
,, 7. *a. b. c. d.* Fluid cavities with bubbles in silica of granite. Ballyknockan.

---

[1] Paper No. 1, Observations on the Microscopic Structure of Irish Granites *eol. Mag. Vol. X. p. 196.*

ɑ. 8. 9. 10. Tubes in silica of granite. Magnified 200 diameters. Ballyknockan.
„ 11. A belonite or trichite in silica. Magnified 200 diameters. Ballyknockan.
„ 12. Imperfect crystal of orthoclase, showing "cross-banded" structure. Magnified 25 diameters. Ballyknockan.
„ 13. Portion of silica, with cells, "trichites" and belonites. Magnified 200 diameters. Ballyknockan.
„ 14. Crystal of triclinic felspar. Magnified 25 diameters. Ballyknockan.
„ 15. Constellation of gas (?) cavities in silica. Magnified 40 diameters.
, 16. One of the cells. Magnified 300 diameters.

I.—ON THE DISCOVERY OF A SPECIES OF STARFISH IN THE DEVONIAN BEDS OF SOUTH DEVON.

By ARTHUR CHAMPERNOWNE, M.A.

HE only mention hitherto, so far as I know, of the occurrence of Starfish in British Devonian rocks is that given by Mr. ıeridge in his list of Devonian fossils (Quart. Journ. Geol. Soc., . xxiii. p. 619), viz. *Protaster*, sp., and *Palæaster*, sp., from the ton beds of North Devon; therefore the discovery of a species in ıth Devon rocks may not be without interest.

he locality which yielded the few specimens in question is a all quarry or road-side excavation at Inglebourne House, near rbertonford (about three miles S.S.W. of Totnes), in coarse slates h one or two thin gritty layers, on one of which, forming part of floor of the quarry, were the impressions. The dip is about S.E. ? East of South *Magnetic*) at 15°, crossed by cleavage at a much her angle towards the South. The steady dip at this spot is conned by a small quarry in the adjoining field.

iewed in connexion with the Harbertonford limestone and the te quarry at Roster Bridge, the beds would appear to belong to *Upper* South Devon series; but of this it is difficult to speak with tainty, owing to the fact that there is no limestone for some miles st of Harbertonford. Its line of strike, however, appears to pass r the Roster Bridge quarry south of the beds with the Starfish.

he limestone at Harbertonford dips North at low angles, generally more than 10°, but close to the vicarage it is 25°. At Roster Bridge, ere large Spirifers and other fossils are numerous, the cleavage he predominant feature; but there also the true beds appear to dip he North. Possibly a fault passes between these and the beds at lebourne, which dip S.E., the downthrow being to the North.

lately visited the locality in company with Mr. J. E. Lee and Mr. ige-Browne, of Inglebourne House, and the above was the view en by the latter, who considered the slates of Roster Bridge quarry deeper in the series than the beds around his house, and the latter nearly on the horizon of the limestone, although I think they are ıewhat newer. Our search for Starfish was, however, fruitless.

With regard to the specimens themselves, the best of which I rusted to my friend, Mr. J. E. Lee, to exhibit at the British ociation, Bradford, in September last, I am pleased to hear that y are about to be described by Mr. Woodward, a more experienced eontologist than myself. The object of the present note is merely record the fact *of their occurrence*, and give some account of the *ality*.

RTINGTON HALL, TOTNES, DEVON.

IV.—DESCRIPTION OF A NEW SPECIES OF STARFISH FROM THE DEVONIAN OF GREAT INGLEBOURNE, HARBERTON, SOUTH DEVON.

By HENRY WOODWARD, F.R.S., F.G.S., etc.,
of the British Museum.

PROBABLY no part of England has received more careful attention from geologists than Devonshire, both North[1] and South,[2] but although the lists of fossils are large, the fossils themselves are often very difficult to determine, owing to the cleavage and metamorphism to which the rocks containing them have been subjected.

Starfishes must undoubtedly be reckoned among the rarest of Palæozoic fossils, and next in beauty to the Crinoids. As many as 17 genera and 57 species have been described from the Silurian, 5 from the Devonian, and 3 from the Carboniferous series, whilst many others yet remain unnoticed in collections.

In the Museum of Practical Geology, Jermyn Street, are several undescribed specimens from the Upper Devonian of Pilton, N. Devon, which have provisionally been referred by Mr. Etheridge to the genera *Protaster* and *Palæaster.*[3] The following is a transcript of my note-book at the time I examined them.

No. 1. *Protaster*, sp., Upper Devonian, Pilton.
An elegant little starfish, with five flexible rays and a somewhat broad disk (very like *P. Sedgwickii*, Forbes, but not so long in the arms), about one inch in diameter to the extremities of the arms.

No. 2. *Protaster*, sp., Upper Devonian, Pilton.
A larger form than the preceding one, four inches in diameter, five-rayed, arms long, flexible, spinose; the pentagon formed by the oral plates well marked. This species resembles *Protaster Miltoni.*

No. 3. *Palæaster* (?), sp., Upper Devonian, Pilton.
Five-rayed, flexible arms; this is marked *Palæaster*, but is probably a *Protaster*, like No. 2.

No. 4. *Palæaster*, sp., Upper Devonian, Pilton.
A stout-armed, five-rayed Starfish, resembling *P. asperrimus*, Salter, and *P. imbricatus*, Salter.

Mr. Etheridge informs me that numerous specimens of new and undescribed Starfish, which had been collected by the late Prof. J. Beete Jukes, F.R.S., during the preparation of his papers on North Devon, are preserved in the Museum of the Irish Geological Survey, Dublin; some are in the hands of Prof. Wyville Thomson, F.R.S., for examination; others are to be seen in the cabinet of Townshend M. Hall, Esq., F.G.S., Pilton Parsonage, Barnstaple.

In a former paper published in this MAGAZINE, "On a New Silurian Starfish, *Eucladia Johnsoni*, H. Woodw. (see GEOL. MAG. 1869, Vol. VI. Pl. VIII. p. 241), I have given a detailed list of all the Silurian species with which I was then acquainted. By adding the following genera and species to that list, we shall complete the details of all the Palæozoic species with which I am acquainted.

---

[1] See Memoir by Mr. Robert Etheridge, F.R.S., "On the Physical Structure of West Somerset and North Devon, and on the Palæontological Value of the Devonian Fossils," Quart. Journ. Geol. Soc. 1867, vol. xxiii. pp. 568–698.

[2] See Memoir by Dr. Harvey B. Holl, F.G.S., "On the Older Rocks of South Devon and East Cornwall," Quart. Journ. Geol. Soc. 1868, vol. xxiv. pp. 400–454, and pl. xvi.

[3] See Mr. Etheridge's very elaborate and important paper already quoted, Quart. Journ. Geol. Soc. vol. xxiii. p. 619. In another table (p. 670) one of these, *Palæaster*, is *starred* as Middle Devonian; this is a typographical error: they are *both* Upper Devonian *forms.*

1. *Asterias constellata*, Thorent, Coal-measures. M. Geol. iii. 259, t. 22, fig. 7; Bull. Geol. 1844, 208, t. 3, figs. 1–3.
2. *Schænaster Watchsmuthi*, Meek and W., Lower Carboniferous, Burlington, Iowa. Palæontology of Illinois, 1866, p. 499, pl. 17, fig. 4.
3. *Ophiura* (?) *ramosa*, Fahrk, Mountain Limestone, Russia. Bull. Moscow, 1844, 804.
4. *Aspidosoma Tischbeinianum*, Ferd. Roemer, Devonian, Bundenback, Birkenfeld. Palæontographica, Bd. ix. 1862–4, pp. 143–152, pl. xxiii.–xxix.
5. *Asterias asperula*, F. Roemer, Devonian, Birkenfeld. *Op. cit.*
6. ——— *spinosissima*, " " " "
7. *Helianthaster Rhenanus* " " " "
8. *Acroura* (*Ophiura*) *Schlotheimii*, Münster, Upper Silurian.
9. *Trochitaster plumiformis*, Wright, Upper Silurian, Dudley. Quart. Journ. Geol. Soc. 1873, vol. xxix. p. 421.
10. *Protaster* (*Ophiura*) *obtusa*, Eichw., Upper Silurian, Russia. Lethæa Ross. p. 193.
11. ——— *Petri*, Salter, Cambrian, Bala. Cat. Woodw. Museum, 1873, p. 47.
12. *Palæaster Caractaci*, Salter, Cambrian, Church Stretton. Cat. Mus. Pract. Geol. p. 30.
13. ——— (*Asterias*) *primæva*, Salter, Cambrian, Bala. Quart. Journ. Geol. Soc. vol. i. p. 8.
14. ——— *squamatus*, Salter, Cambrian, Bala. Cat. Woodw. Mus. Camb. 1873, p. 47.

The following is a summary of the known Palæozoic genera:—

Order I. ASTERIADÆ. Fam. 1. Asteriæ.

Genus 1. *Aspidosoma*, sp. 1. Devonian, Ardoise.
2. *Asterias*, sp. 3. Devonian and Carboniferous.
3. *Edrioaster*, sp. 1. Trenton Limestone, Canada West.
4. *Glyptaster*, sp. 4. Niagara Group, Indiana, etc.
5. *Palæaster*, sp. 21. Lower Silurian to Carboniferous.
6. *Palasterina*, sp. 5. Upper Silurian, Shropshire, etc.
7. *Palæocoma*, sp. 6. " "
8. *Petraster*, sp. 1. Niagara Group, Canada West.
9. *Ptilonaster*, sp. 1. Chemung Group, New York.
10. *b. Stenaster*, sp. 1. Trenton Limestone, Canada West.
11. *c. Tæniaster*, sp. 2. " Montmorency.
12. *a. Schænaster*, sp. 1. Lower Carboniferous, Iowa.

Fam. 2. Urasteriæ.

13. *Urasterella* (?), sp. 1. Trenton Limestone, Canada West.

Fam. 3. Goniasteriæ.

14. *Palmipes* (H. W.), sp. 1. Wenlock Limestone, Malvern. [Coll. Dr. Grindrod, *not yet described.*]

Fam. 4. Solasteriæ.

15. *Helianthaster*, sp. 2. Devonian, Ardoise and South Devon.
16. *Lepidaster*, sp. 1. Wenlock Shale, Dudley.
17. *Trochitaster*, sp. 1. " "

Order II. OPHIURIDÆ. Fam. 5. Ophiuræ.

Genus 18. *Acroura*, sp. 1. Upper Silurian.
19. *Eugaster*, sp. 1. Hamilton Group, New York.
20. *Protaster*, sp. 7. Lower Silurian—Devonian.
21. *Palæodiscus*, sp. 1. Upper Silurian, Shropshire.
22. *Ophiura* (?), sp. 1. Carboniferous Limestone, Russia.

Fam. 6. Euryales (?).

23. *Eucladia*, sp. 1. Wenlock Limestone, Dudley.

The specimens from Mr. Champernowne's collection, which it has been my good fortune to examine, belong to the Asteriadæ, and to that peculiar many-rayed family, the SOLASTERIDÆ, or "sun-stars," o which only three species, belonging to as many distinct gener —namely, *Helianthaster*, *Lepidaster*, and *Trochitaster*—have hithert been described from the Palæozoic rocks, whilst a starfish whic has been referred by the late Prof. Edward Forbes to the livin genus *Solaster*, occurs as early as the Great Oolite.[1]

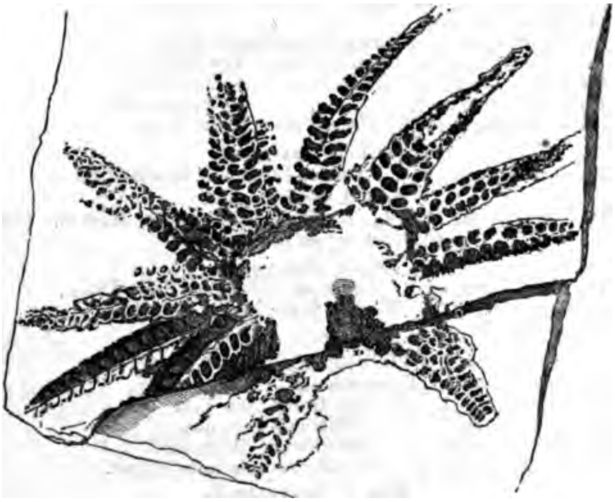
Of the other Devonian genera, *Aspidosoma*, *Asterias*, and *Palæast* belong to the family of ASTERIADÆ, whilst *Protaster* is referred to t OPHIURIDÆ.

Although, as a rule, the number five is dominant among t Echinodermata, and regulates the forms and organs of the starfish yet we find numerical variation occurring more frequently in t order than among the Ophiuræ or the Sea-Urchins.

The number of arms is not of specific value, although in seve instances it may be of generic significance. In *Luidia* and *Solast* says Prof. Edward Forbes, it is of least importance.

The purple sun-star, *Solaster endeca*, has from nine to eleven ra the common sun-star, *Solaster papposa*, has generally from twelve thirteen rays, sometimes as many as fifteen; whilst the *Solas helianthoides*, a fine specimen of which I possess, from the weste shores of South America,[2] has no fewer than thirty-four arms!

The *Solaster Moretonis*, from the Great Oolite, has thirty-th arms; *Helianthaster Rhenanus*, from the Devonian slates of Ardoi has sixteen arms; *Lepidaster Grayi*, from the Wenlock Limesto Dudley, has thirteen arms; *Trochitaster plumiformis*, from the sa formation and locality, has ten rays: both the examples of Champernowne's Starfish have eleven arms.



Helianthaster filiciformis, H. Woodw., Devonian, Harbertonford, South Devon. (Twice the natural size.)

---

[1] *Solaster Moretonis*, Forbes, Mem. Geol. Surv., Decade 5, t. 1.

[2] *Fide Forbes, possibly* from Australia?

The specimens are preserved as casts of the calcareous skeleton, from which all the integument has been removed. We cannot therefore hope to discover the madreporiform tubercle, or those delicate tufts of spines with which the dorsal surface of the disk and arms of most of the Solasteriæ are invested.

Each arm is composed of from fifteen to twenty pairs of small and somewhat ovate plates, which unite along the centre and form the roof of the radiating grooves which one sees on the ventral side of all existing Starfishes, and in which those curious and delicate tubular extensile organs, the suckers (which serve the office of feet, and by means of which the animals can walk about with great facility), are ranged.

In the Solasteriæ there are only two rows of these suckers in each avenue, whilst in the Asteriæ there are four.

The casts of these plates, with their slender mesial connecting ridge, resemble one of the delicate pinnules of the leaf of a *Lastræa*, or, when viewed as a whole, one is reminded of the little plants of *Asplenium trichomanes*, common on our country walls.

The disk, unfortunately, is not preserved in either of the specimens sent to me, but it must have measured 10 mm. in breadth. The arms are 17 mm. in length, and near their junction with the body are 5 mm. broad; the greatest breadth of the entire Starfish is about 45 mm.

Writing of *Lepidaster Grayi*, Prof. Edward Forbes observes:—

> "This fossil bears at first sight a strong resemblance to a Starfish of the genus *Solaster*, but in reality it possesses characters so peculiar as without doubt to stamp it as a separate generic type, and even to render doubtful its position among true Starfishes, and to raise the question whether it be not a connecting link between that order of Echinoderms and Crinoids.
>
> The disk is very little more than two inches in diameter. It is so injured that its elements cannot clearly be made out, but it appears to have had a framework of closely set polygonal ossicula. The rays are arranged around it equidistant from each other, like so many spokes of a wheel. Their average length is one inch and one-twelfth, and their breadth towards the base four-twelfths. They are all regularly lanceolate. Their under-surfaces are exposed on the slab, and are composed of thick transversely oblong plates, slightly overlapping each other in a scale-like fashion, and ranged in *four longitudinal rows*, two on each side of a central or ambulacral groove, which is itself toward the extremity in some instances partially filled up by small polygonal intervening plates. Of the two rows of border plates on each side of the groove, the inner series is formed of oblong obscurely hexagonal ones, with traces of punctations and grooves on their surfaces as if for spines. The ray that is most perfect exhibits twenty-five plates in each row. The outer series consists of suborbicular or obscurely polygonal plates, which, like the inner ones, are slightly convex on their surfaces. The upper surface of the ray, and probably of the body, was composed of numerous small polygonal, nearly flat ossicula, closely set and of various sizes." (1850, Mem. Geol. Surv., Decade iii. pl. i. p. 1.)

In *Helianthaster Rhenanus* (Roemer) the disk is 30 mm. broad, and the arms are double that in length.

The arms themselves are bordered on each side by small knobs or ossiculæ, with traces of two finer lines of obliquely-placed and smaller plates along the middle of each arm, bordering the ambulacral groove; whilst a small oval plate marks the base of and separates each arm where it joins the body. *There are also remains of spines on the borders of some of the arms.* The disk is not preserved, and

Dr. Roemer therefore concludes it to have been soft and membranaceous, and not covered with hard plates (as in *Lepidaster*, *Goniaster* etc.).

When perfect, *H. Rhenanus* must have measured six inches across (150 mm.), rather more than three times the size of Mr. Champernowne's specimen. Size, however, cannot be looked upon as of much importance, nor can the number of arms in this family be relied upon as conclusive.

In *Lepidaster* we have seen, by Forbes's description, the arms were clothed, as in *Goniaster* and *Oreaster*, with external calcareous plates, reminding one of the arms of the Crinoids; the disk is also covered with polygonal plates, and is twice as broad as the arms are long. *Trochitaster* is, at present, only known by its *outline*, and therefore cannot be taken into consideration.

I am inclined therefore to refer Mr. Champernowne's specimen to Roemer's genus *Helianthaster*, in preference to the alternative of creating a new genus for its reception. Its fortuitous resemblance to a fern has induced me to propose the specific appellation of *filiciformis* as less objectionable than the alternative of giving it a topographical designation, the appropriateness of which might shortly be obliterated by its being found by Mr. Champernowne and other ardent geologists in half a dozen other localities in South Devon.

V.—Descriptions of New Fossils from the Devonian Formation of Canada West.

By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E.;
Professor of Natural History in University College, Toronto.

(PLATE II.)

HAVING been engaged for some time in collecting and studying the organic remains of the Corniferous Limestone and Hamilton formation of the western portion of the Province of Ontario, I propose, in the present communication, to describe some of the new species which have come under my notice, these being chiefly referable to the groups of the Corals and the Polyzoa. A portion of the new material which I have collected I have already described in the "Annals of Natural History" and in the "Canadian Naturalist," and a portion still remains for more extended examination. Some of the species here described, also, will be fully illustrated in the detailed Report on the Devonian Fossils of Western Canada, which I am now preparing for the Government of the Province of Ontario. Under any circumstances, the Corniferous and Hamilton deposits of Western Canada are so richly fossiliferous, that more extensive investigations than I have been able to carry out would certainly result in the bringing to light of numerous new forms of animal life. The total number of species comprised in my collections from these formations amounts to about one hundred and sixty or seventy, of which between thirty and forty are apparently new; but in the case of some of these the materials at present in my hands are not sufficient for description. Of this number no less than seventy-five belong to the corals, about forty

Fig. 1.

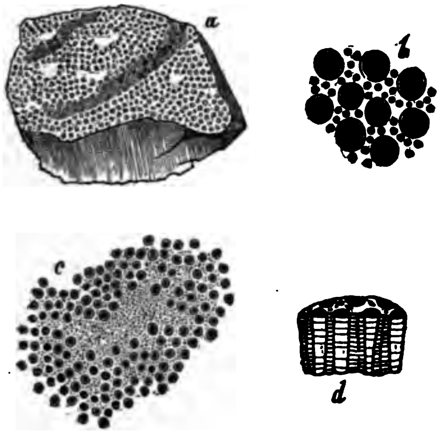


Fig. 2.

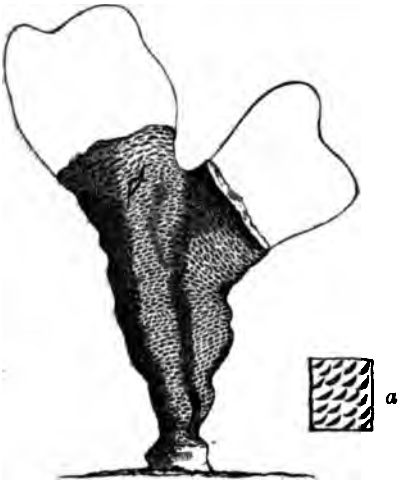


Fig. 1.—*Callopora incrassata*, Nich. *a*. A fragment, natural size. *b*. A portion of the surface magnified, showing the calices and cœnenchymal tubuli. *c*. A portion of the surface less highly magnified, showing one of the vacant areolæ surrounded by corallites. *d*. Vertical section of a fragment enlarged. From the Hamilton Group.

Fig. 2.—*Alveolites frondosa*, Nich., partially restored in outline, natural size. *a*. A fragment of the surface magnified. From the Hamilton Group.

are Brachiopods, and the remainder are distributed amongst the *Polyzoa*, *Gasteropoda*, *Lamellibranchiata*, *Annelida*, *Trilobita*, and *Crinoidea*.

Genus CALLOPORA, Hall.

Gen char.—Corallum compound, massive, encrusting or ramose; corallites minute, tubular, separated by a still more minutely tubular cœnenchyma. The cœnenchyma always rendered vesicular by numerous transverse diaphragms, and the corallites also generally tabulate. Septa rudimentary or absent.

The genus *Callopora* includes a number of corals which range from the Upper Silurian (Niagara group) to the Devonian, and which in some instances have decidedly the aspect of *Polyzoa*. The affinities of the genus are, however, beyond question, so far at any rate as concerns those species which have come under my observation. *Callopora*, beyond all doubt, is a genus of Tabulate Corals, and finds its nearest allies in the genera *Heliolites* and *Fistulipora*. From the former of these *Callopora* is separated by the absence of septa, and from the latter by the fact that the tubuli of the cœnenchyma are regularly tabulate, whilst the corallites themselves have the theca either open or partitioned off by a few remote horizontal tabulæ. There is also a much greater disproportion between the size of the corallites and that of the tubuli of the cœnenchyma than is the case with *Fistulipora*.

One large species of *Callopora*, which perhaps may subsequently be found to admit of subdivision into two, has occurred to me in the Devonian formation of Western Ontario; and this is clearly distinct from all previously recorded forms.

CALLOPORA INCRASSATA, Nicholson. Plate II. Fig. 1.

Spec. char.—Corallum sometimes encrusting foreign bodies, sometimes forming large expansions, or sometimes constituting hemispheric or globular masses, which are composed of numerous concentric layers superimposed one upon the other. Corallites very minute, tubular; their circular calices slightly elevated above the general surface, and surrounded by a prominent margin. From three to five calices in the space of one line, separated by intervals of from half to two-thirds of their own width. Corallites sometimes with the cavity of the theca undivided, but more commonly partitioned off by a few remotely placed horizontal tabulæ. Cœnenchyma composed of exceedingly minute tubuli, which are divided by close-set horizontal diaphragms. The surface exhibits, at intervals of about two lines, elongated star-shaped spaces, sometimes smooth, sometimes punctate or minutely pitted, which are not penetrated by tubes of any kind, and appear to be quite solid. There are generally from three to six corallites surrounding these vacant spaces which are larger than the average, and the spaces themselves have a long diameter of from one to two lines by a shorter diameter of half a line. In some specimens, also, the surface exhibits occasional large conical elevations, pierced each by a single canal, the diameter of which is about one line, and which descends vertically into the mass.

The characters of *Callopora incrassata* (Fig. 1) are very remar able, and I am not altogether satisfied that two closely related speci have not been included under the above description. That we ha to deal here with a Tabulate Coral allied to *Heliolites* and *Fistulipo* is sufficiently clear; but there are many anomalous points present by the present fossil. The specimens which I have included und this head occur in at least three forms. Some of them form th crusts upon *Heliophyllum Halli*, *Cystiphyllum vesiculosum*, or oth corals, themselves in turn supporting the tubes of *Ortonia* *Spirorbis*, or the creeping stolons of *Aulopora*. Others form fl tened or undulating expansions, supported upon a thin concentricall wrinkled epitheca. Others, again, form irregular or hemisphe masses, varying in size from an inch in diameter, or less, up to t size of a man's head, and composed of numerous concentric laye The majority of examples exhibit the singular areolæ or clear spa on the surface, which are neither penetrated by the corallites n by the tubuli of the cœnenchyma (Fig. 1*c*). These spaces a usually elongated, and often somewhat depressed below the gene surface, and prolongations extend from them in a star-like mann The corallites in their immediate neighbourhood are also usuall some or all, larger than the ordinary ones. Only a few specime exhibit the large conical perforated eminences above alluded t but in those that do, these structures appear to belong properly the fossil and not to be extraneous. In other minor respects differe specimens differ considerably amongst themselves. The exampl from the Corniferous Limestone are mostly of large size, t corallites are comparatively small, the intervals occupied by t cœnenchyma are proportionately wide, and the fact that the cœne chyma is minutely tubular cannot be determined. I feel, ho ever, pretty sure that these peculiarities are to be ascribed to t manner in which the specimens from this formation are fossilise In the specimens from the Hamilton formation, again, the peculi vacant areolæ cannot always be recognized, and appear to sometimes absent over considerable areas. Most of the Hamilt specimens show very clearly the tubular character of the cœne chyma, but there is a good deal of diversity as to its amou Some examples have the corallites separated by nearly their ow width, the interspaces being filled with circular or polygonal tubul Others, on the other hand, have the corallites nearly in conta with but a single row of very minute tubuli between. An epithe is only occasionally present, and the flattened expansions often car corallites on both sides.

Locality and Formation.—Corniferous Limestone of Port Colborn and more abundantly in the same formation at Hagersville. Comm in the Hamilton formation at Widder, and also at Bartlett's Mi near Arkona, in the townships of Bosanquet and South Williams.

Genus ALVEOLITES, Lamarck.

Mr. Billings has already recorded six species of *Alveolites* fro he Devonian rocks of Western Canada, four from the Hamilt roup, and two from the Corniferous Limestone (Canadian Journ new series, vols. iv. and v.). To these I have now to add five species from the Corniferous Limestone, and a sixth from the Hamilton shales, all of which appear to be distinct from previously described forms.

ALVEOLITES FRONDOSA, Nicholson. Plate II. Fig. 2.

Spec. char.—Corallum forming elongated, sometimes palmate expansions, which appear to have grown in an erect position from a rooted base, and which carry calices on both sides. The width of these expansions seems never to have been over an inch and a quarter, often less, and the thickness rarely exceeds two lines, whilst the height is unknown, but certainly sometimes exceeded two inches. The corallites spring from the median plane of the frond on both sides, and are very oblique to the surface. Walls of the corallites exceedingly thick; calices small, transversely oval or subtriangular, arranged in oblique lines, their long diameter being not more than from one-fourth to one-third of a line, with a transverse diameter one-half less. The inferior lip of the calice is thin and prominent, but there are no traces of any internal ridge or tooth. The calices are separated by intervals of about one-third of a line in the vertical direction of the frond, and one-fourth of a line, or less, in the transverse direction of the frond.

There can be little question as to the distinctness of this not uncommon species. It is readily distinguished from all other species of the genus except *A. Fischeri*, Billings, by its peculiar form and mode of growth, and it is separated from this by the very much smaller size of its corallites, and their much closer arrangement. From the thickness of the walls of the corallites in this, as in some other forms from the Devonian rocks of Ontario, the appearance is produced of the corallites being imbedded in a more or less abundant cœnenchyma, which, however, has no true existence. For this reason, also, the aspect of the fossil differs in some degree from that of the typical species of *Alveolites*, and more or less resembles that of *Cœnites*, Eichwald (=*Limaria*, Steininger), from which it is separated by the absence of calicinal teeth.

Locality and Formation.—Common in the Hamilton formation at Bartlett's Mills near Arkona, township of South Williams.

ALVEOLITES SELWYNII, Nicholson. (Fig. 3.)

Spec. char.—Corallum forming an irregularly-shaped crust, or depressed mass, about one line in thickness. The corallites are exceedingly oblique to the surface, and open by calices which have the form of curved or lunate slits, the length of which is about three-quarters of a line, whilst their width in the centre is only a tenth of a line, or thereabouts. The calices are placed in irregularly alternating lines, or sometimes in an indistinctly subspiral manner, and are about half a line or three-quarters of a line apart, the thickness of the walls of the corallites being thus very considerable.

This curious form belongs to the same section of *Alveolites* as *A. sub-orbicularis, Lam.*, *A. Goldfussi*, Billings, and *A.* depressa, Edw. and H., but it presents some peculiarities which render its reference to *Alveolites* not altogether certain. It is distinguished by the remote fissure-like calices with nearly parallel walls, and by the absence of any distinct concentric arrangement of the corallites. In the shape of the calices, it somewhat resembles *Cœnites labrosus*, Edw. and H.; but it is in reality very different, both in its general form and its real structure.

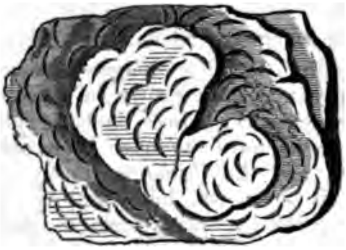


Fig. 3.—A fragment of the upper surface of *Alveolites Selwynii*, Nich., magnified. From the Corniferous Limestone.

I have only seen a single example of the species. It is dedicated to Alfred R. C. Selwyn, Esq., F.G.S., the Director of the Geological Survey of Canada.

Locality and Formation.—Corniferous Limestone, Port Colborne.

(*To be continued in our next number.*)

VI.—The Isle of Thanet. The Ammonite Zone, the Depth of the Chalk in Section, and the Continuity of its Flint Floorings.

By F. A. Bedwell, M.A., F.R.M.S.

In the summer of this year I laid before the Geologists' Association some particulars of fourteen large Ammonites which I had found in the Chalk cliffs east and west of Margate. The following is the result of three weeks' further work on these cliffs.

There are 89 Ammonites or remains of Ammonites to be seen *in situ*, between Cliff End, Birchington, and Kingsgate Bay. I have marked on the cliff itself the position of each of the 89, by placing on the Chalk a black cross thus + at a point on the eye level, which is as nearly as possible "three yards to the eastward of a perpendicular line passing through the Ammonite itself." When two or more lie near each other, I have indicated the fact by adding dots to the cross; and in one case where I have removed an Ammonite, I have placed a circle with a dot in the centre on the spot, and in another instance in a cave the cross is placed close to the specimen itself. I have measured the depth and height of each Ammonite, the first relatively to a "datum line" and the second relatively to the sand line. The "datum line" which I selected is the only one available; it is a line of nodular flints which is exhibited nearly continuously from Birchington to Kingsgate. It is in fact a line which actually guided me to the majority of the Ammonites; and although it is in some places difficult to decipher, yet it has very distinct characteristics of its own. It is nearly always double, and its individual flints seldom run large, and are separated from each other, generally by a foot of chalk, frequently by much more, but seldom by less. The minimum distance below it at which I have found a specimen is 4ft. 6in. and the maximum 60ft. 3in. Referring to this band as a "datum line," and grouping in six different "averages" all the 89 various measurements so taken, the following particulars are obtained.

TABLE OF AVERAGE DEPTHS OF AMMONITES BELOW "DATUM LINE."

No. of Specimens.	Average depth below "datum line."		Greatest depth.		Least Depth.		Depth Unknown.
	ft.	in.	ft.	in.	ft.	in.	
8	6	8	8	0	4	6	
32	12	0	14	6	9	0	
6	16	8	17	9	15	6	
25	20	2	22	3	18	0	
11	25	2	27	5	23	5	
4	32	9	35	0	31	1	
1	46	9	...	...	...	...	
1	60	3	...	...	...	...	
1	...	...	...	...	...	...	—
89							

It will be seen from these figures that the 12-foot line and the 20-foot line both represent periods of special maximum development. Indeed seven of the specimens on the 12-foot line lie in a space of 200 yards, and three of them almost touch each other, and look very much as if they had actually "died together."

The large majority of the specimens are referable to *Ammonites leptophyllus*. I identified thirty-five of this kind. I also identified four as *A. Lewesiensis*, and one as *A. peramplus*.[1] The rest are indistinct.

In addition to these particulars, I am also able to give exact detailed

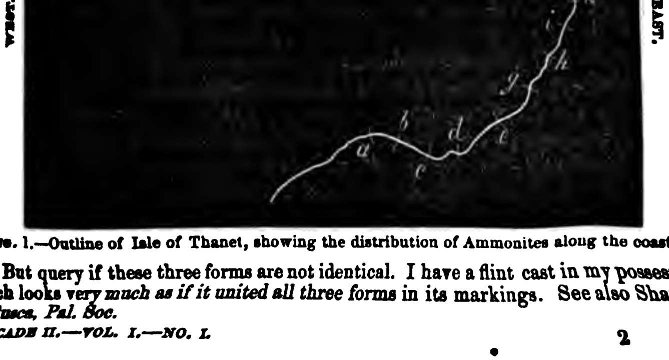


FIG. 1.—Outline of Isle of Thanet, showing the distribution of Ammonites along the coast.

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[1] But query if these three forms are not identical. I have a flint cast in my possession which looks very *much as if it united all three forms* in its markings. See also Sharpe's *Mollusca, Pal. Soc.*

measurements of the whole of the Chalk seen in section alo
cliffs of the Island, and these details will be found in the accon
ing tabular statement. Altogether there is a depth of 180 f

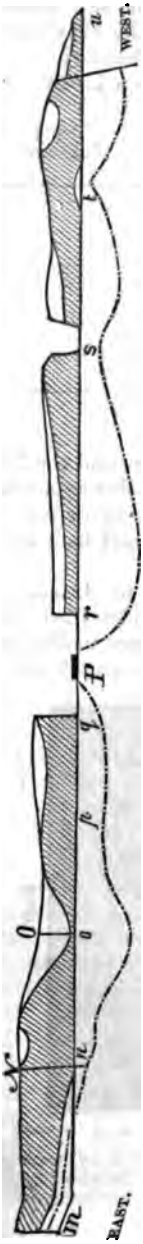

Fig. 2.—Cliff-section from Birchington to Kingsgate.

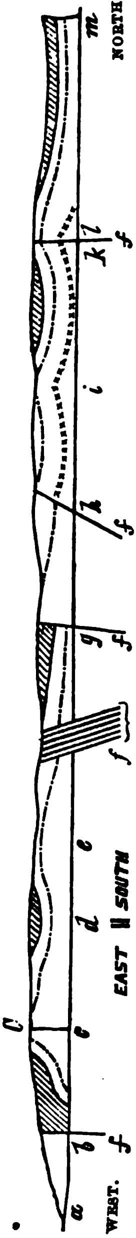

Fig. 3.—Cliff-section from Kingsgate to Pegwell.

chalk in the section; the hig
seen at Foreness (point O in S
map), and the lowest is seen
bottom of the cliffs, just befo
turn to Pegwell (point C).

Out of the whole 180 fe
Ammonite zone, according
position of the specimens fou
to the present time, covers a
of between 55 and 56 feet.
searched for specimens in the
above and below these boun
but at present without s
Strange to say, the Ammonite
so far as I have now identi
will be found to coincide with
in which there are no lines o
individual flints occur rarely th
out the area of the zone, and
or spurts of flint show ther
here and there, and someti
connexion with the Ammonite
selves; but excepting just ab
lower boundary of the zone
are no lines of flints exhibite
and at present it looks as if
pearance and disappearance
Ammonites was coincident w
disappearance and re-appear
the flint lines.

The various undulations
Chalk are shown in the accon
ing sections, which, howeve
necessarily much curtailed in
of detail.

The three uppermost ba
flint indicated in the accomp
table appear in various plac
tween Birchington and King
and wherever they are seen
always preserve their relativ
tances and peculiar features.
are all more or less alike in a
ance—the flints in the two
lines being larger than those
lowest line.

At Kingsgate and the North
land respectively, two ban

the "Deposition theory," by which I mean the theory of the formation of mountains by removal of matter from one portion of the earth and its deposition on another portion.[1]

(*a*.) The first argument that Mr. Fisher adduces against the Deposition theory is that any lateral pressure of expansion must be taken as strictly horizontal, that the pressure on one side would exactly balance that on the other, and that no upward rising would take place. But the pressure relied upon by Mr. Fisher for producing mountains is just as horizontal as the pressure produced by expansion; and if a cubic foot of rock would be simply compressed by the horizontal pressure caused by expansion, why should not the effect be the same if the horizontal pressure was produced by the contraction of the nucleus? Further on in his paper (p. 250), Mr. Fisher allows that the direction of the forces would be the same in both cases.

Practically we know that a perfectly horizontal sheet of dry paper stretched on a board will wrinkle up when its dimensions are increased by damping it, and that a perfectly straight bar of iron, firmly fixed at each end, will bend if heat is applied to it. Mr. G. Maw has also given (GEOL. MAG. 1868, Vol. V. p. 294) an excellent example of the displacement of the coping-stone of a wall by expansion; and the crust of the earth must do the same unless it crushes. From observation we know that anticlinal curves have been formed, and therefore that the crust does not always crush up.

Mr. Fisher also says that "we have no right to consider the crust rigid, when regarded in proportions of sufficient dimensions to admit of these lateral pressures being otherwise than sensibly in the same straight line, but in opposite directions." But in his first paper on the Elevation of Mountains (Trans. Cam. Phil. Soc. 1869, xi. p. 4), he not only says that the portion of the "rigid" spherical shell that he is considering is kept in equilibrium by its attraction towards the centre (*i.e.* its weight), and by the pressures tangential to great circles round the circumference of the shell (*i.e.* the lateral thrust of the arch or dome), but he calculates the amount of the latter, and shows that it is independent of the size of the shell,—except so far as the size alters the weight; and I really fail to see the difference between this and stating, as I did, that each portion of the rigid crust is partly maintained in its place by the lateral thrust of the arch.

(*b*.) Mr. Fisher's next argument is that the rocks would crush under this pressure, and not rise up in anticlinals. But in order to crush there must be some space to crush into; and, by the Deposition theory, it is the *lower* beds that are undergoing compression, while the upper are not; and in order to relieve the compression, the upper beds must be forced up, either by fractures being formed and certain parts only raised, or else altogether into one or more dome-shaped elevations.[2] As the last requires much the least work, it is the way in which the pressure would be relieved.

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[1] I find that this theory was first suggested by Mr. Scrope (Volcanoes, 1st edition, 1825, p. 30), so that it has no right to the name of the Herschel-Babbage theory, as I previously called it.

[2] *To prevent misconception, I must explain* that by a dome-shaped elevation I do

be no doubt that they were respectively all at one time continuous and in the same horizontal plane.

The distance from Margate Harbour to St. Margaret's Bay is about nineteen miles, and from Kingsgate to Westgate is six miles; and here then we have evidence of lines of flint being formed over an area of at the least about 120 square miles—"by chemical processes identical and simultaneous in their modes of operation." But, at the same time, it would be no unfair deduction to take at least the square of 20 miles as the probable minimum extent of the field represented by the section thus exhibited to view; while I cannot help anticipating that these and other bands will hereafter be identified over a very much more extended area even than 400 square miles.

To return to the Ammonites, many of them are well worth a visit; one in particular is a magnificent basin, four feet at least in diameter if not more, and out of which the sea has worked the chalk, showing the contour of many of the chambers, and exposing to view a natural internal section of a portion of the shell. It lies between the points *t* and *s* on the map, and is on a low platform of rock just under the name of Mr. K. Loder, a gentleman who has added lustre to his name by unconsciously associating it, in letters of appropriate proportions, with this gigantic natural relic.

Should any geologist desire to visit the section, I shall be happy at any time to furnish him with exact details, which will enable him more easily to find all the Ammonites. A letter addressed to "Lincoln's Inn" will be sufficient.

On reference to the sections, it will be seen that I have figured the Ammonite-bed as appearing in three different places between Kingsgate and Pegwell; not that I have found any Ammonites *in situ* in those three places, though I found a fragment on the beach between the points *i* and *k*, but the chalk, at the three places which are indicated by the shading, brings, by its undulations, the Ammonite-bed on to the face of the cliff at these points. When we reach Pegwell itself, the Ammonite-bed is clearly represented for nearly half a mile; and four specimens have been found there *in situ*, by Mr. Leonard Wray, jun., of Ramsgate, who has, I believe, marked their position for me with the letter W. At Pegwell Bay 51 feet of the chalk, which is to be seen on the Margate cliffs, is wanting, and has been carried off the upper portion of the cliff.

The total depth of the chalk in section is obtained by the following addition: $\text{Oo} + \text{Nn} + \text{Cc} = 32 + 74 + 74 = 180$,—the heights Oo, Nn, and Cc, being the three lines thus figured in the accompanying sections, and which I measured with a plumb-line and measuring-rod.

The upper edge of the shaded band represents the "datum line," being the line of flints which guided me to the Ammonites; the lower edge of the shading gives a line of flints in which the lowest Ammonite appears.

I have added a table showing the distribution of the specimens, 93 in all, along the whole section.

TABULAR STATEMENT OF CHALK SEEN IN SECTION IN THE ISLE OF THANET.

eet.	Details.	Exhibited at	Remarks.
0	Highest Chalk in section.	Foreness.	
2	Nodular line of Flints.		
2	Ditto.		
2	Ditto, guiding to Ammonites		
3.6	Upper limit of Ammonite Bed. Oct. 1873.	Near Marsh Bay.	No lines of Flint.
51	Highest Chalk in section at Pegwell.	Pegwell.	
5	Yellow Band of Chalk (Whitaker).	Kingsgate to Pegwell.	
2	Lower limit of Ammonite Bed. Oct. 1873.	Apple Bay, Kingsgate, and Pegwell.	Many lines of Flint.
6	"Three-inch Band" of Flints.	Kingsgate to Pegwell.	
7	Columnar Band.	North Foreland.	
	Lowest chalk in section.	Near Pegwell.	

On the other hand, by the contraction theory, the *upper* beds are subject to the greatest compression, and, having no weight upon them, they would undoubtedly crush.

(*c.*) Mr. Fisher explains very clearly that the interior could not rise higher than the surface by its own pressure; but it does not necessarily follow from this "that any abnormal elevation of a portion of such crust must be owing to lateral pressure," because it might be owing to an increased upward pressure, caused by the sinking of some adjoining area. It shows, however, that the anticlinals could seldom attain the full amount of elevation that is shown in my table, as the abutments must sink; but the table shows that there is an ample margin for such depressions.

(*d.*) Mr. Fisher's fourth argument is that the specific gravity of the disturbed rocks ought to be less than it was before. This would be the case, with the rocks that caused the movement, only while they were heated, and even then the difference would be too small to detect. When the rocks cooled by denudation, they would go back to their original length by faulting, and the specific gravity would be the same as before, or probably rather more, owing to compression. The granitic rocks, however, underlying the dome, would have their specific gravity lowered, and this accords with the best observations on mountain chains.

These are all the arguments that Mr. Fisher can find against the Deposition theory, and they virtually resolve themselves into this question: when rocks are expanded by heat, do they, or do they not, crush up? The best answer is found by examining the rocks themselves, where we find that extensive areas which have been deeply buried, and which *must* therefore have been considerably heated, are not crushed but thrown into anticlinal and synclinal curves; and *the deeper they have been buried, the more they have been folded,* except when the burying was so long ago that the former more rapid conduction of the interior heat outwards appreciably affected the result.

Mr. Fisher then attacks my illustration of the theory taken from the Weald. But the Weald was not "adduced to give verisimilitude to this theory," as he supposes; neither did I "pretend" to any precise measurements, as any unprejudiced reader will see; but it was given as an example of the way in which the theory might be tested in the field.

I have not access to any precise data as to the thickness of the beds, or the height or breadth of the anticlinal, and exact measurements would have been quite useless unless we also knew exactly the rate of expansion. In geological inquiries mathematical investigation can only be used as a check to our speculations, and as giving us limits beyond which we cannot go.

The average thickness of the Cretaceous rocks was taken from Jukes's Manual (1862, p. 602), and the height of the hills in the Weald from Lyell's "Elements of Geology." If the true thickness

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not mean that a horizontal section through it would necessarily be circular. It may be an ellipse, of which the major and minor axes may have any ratio. From this *point of view all anticlinal* curves are parts of dome-shaped elevations.

Sir W. Thomson, that it is 100 millions of years since the crust of the earth cooled; and if we suppose that the oldest Laurentian rocks date from this period (which is the most favourable supposition that can be made for Mr. Fisher), then the Cambrian period will probably date about fifty millions of years ago,[1] and it is as reasonable a supposition as can be made that, of the other fifty millions of years, thirty-nine were occupied by the rest of the Palæozoic era, nine by the Mesozoic era, and two by the Cainozoic era.[2] So that if we suppose the present surface-features to have originated in the Triassic period, it follows that 11 millions of years is the oldest date that can be assigned to any of them. This, according to Fourrier's estimate of the rate of cooling of the earth, is only sufficient time to allow it to decrease 3¾° F., which is not nearly enough to give the amount of contraction supposed by Mr. Fisher.[3]

8. We can look at this question in another way. If, as Mr. Fisher supposes, the surface of the earth has contracted one mile in a hundred since the present surface-features originated, and the circumference is now 24,856 miles, it must at the time supposed have been 25,104 miles in circumference; and the radius, which is now 3956 miles, must then have been 3995 miles; so that it must have shrunk 39 miles. This in 11 millions of years would be 11·9 yards in 2000 years, or since the time during which we have astronomical observations.

9. If, however, we allow, for the sake of argument, all Mr. Fisher asks, namely, that a mountain half a mile high might be formed on every 100 miles since the present surface-features originated, we then find that, taking the date of the surface as before, Mr. Fisher's mountain has taken eleven millions of years to rise 2640 feet; or it has risen only one foot in 4166 years, which is less than the rapidity of denudation. Mr. Fisher, therefore, is in this dilemma: either the contraction of the earth has been so rapid that it ought to have been noticed by astronomers; or the elevation of land has been so slow that it could not rise above the ocean.

10. Another important objection to the Contraction theory is that mountains have always been formed in those places where deposits have been heaviest, while by that theory those areas should never rise at all. Mr. Fisher says that "the local pressure caused by a fresh deposit . . . will originate a line of elevation along its shore line or boundary," and also "the thickness of the rigid crust being increased by the new deposit, it would offer an impediment to the

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[1] Mr. A. Wallace, on quite independent grounds, puts it at twenty-four millions for the Cambrian, and fourteen millions for the Triassic period. (Nature, i. p. 454, 3rd March, 1870.)

[2] These proportions are taken from the thickness of the various formations in the Northern Hemisphere. In New Zealand the geology is not yet sufficiently advanced to enable us to ascertain the thickness of the formations; but I am of opinion that the proportions between them will be found to be not very different from those that obtain in England.

[3] According to Sir W. Thomson's theory, eleven million of years ago the interior temperature increased at the *rate of* 1° *F. in* 47 *feet*, so that the radiation was very little *more than it is now.*

elevation of ridges beneath it, and throw the whole disturbance into the region just outside its boundary."

11. I have pointed out in my previous papers on this subject that mountains are formed on two different plans: the one associated with volcanic rocks, the other with the crystalline schists; but the Contraction theory supposes that all mountains are identically formed.

12. My last objection to the Contraction theory is that it makes no provision for tension in rocks, although faults prove tension just as surely as contortions prove compression.

I am, therefore, of opinion that the effects on the crust of the earth caused by contraction have been very small, and that these effects have been totally obliterated by the much larger effects caused by deposition.

In conclusion, I wish to explain that I do not consider it necessary that the whole of an area should have been under water in order that it may be raised by the deposition of limestone; for, owing to the lateral conduction of heat, one or more mountain ranges might project out of it as islands. Indeed, I believe that all high mountain ranges are the result of several subsidences and elevations, during which they may never have totally disappeared under the ocean.

VIII.—OBSERVATIONS ON MR. ROBERT MALLET'S PAPER ON VOLCANIC ENERGY IN THE *PHILOSOPHICAL TRANSACTIONS* FOR 1873, PAGE 147.

By G. POULETT SCROPE, F.R.S., F.G.S.

WHILE giving ample credit to Mr. R. Mallet for the ingenuity displayed in his novel suggestion as to the cause of volcanic energy (or Vulcanicity, as he calls it), and for the elaborate experiments and calculations which he brings to its support, Geologists have some reason to complain of the supercilious tone in which he notices, only to throw them aside as unworthy of notice, the theories of all preceding writers on the same subject, who have expressed views differing from that which he adopts. It is needless to give instances of this tone which pervades the whole paper, and must strike every one who reads it.

It is, however, more important to consider—not the manner in which Mr. Mallet's theory is brought forward—but the truth and soundness of the arguments adduced by him in its favour. And for this purpose we shall endeavour to examine impartially some at least of the points it contains that bear on the geology of the question.

Mr. Mallet adopts the same view of the force which has produced the elevations and depressions of the surface-rocks of the globe, with their wrinkled foldings and frequent fractures, as MM. Cordier, Dana, Constant Prevost, Elie de Beaumont, O. Fisher, and many other speculators in geological dynamics, viz. the tangential pressure to which they are supposed to have been subjected under the influence of gravitation by the shrinkage and consequent subsidence of an internal heated and slowly cooling nucleus. I do not here propose to call in question this theory, upon which I have in more than one previous communication to this MAGAZINE briefly adverted.[1]

The theory which is peculiarly Mr. Mallet's own, and is founded upon the assumed truth of that just cited, finds the source of all volcanic heat and consequent energy in the collision and crushing of these subsiding rocks. Now the first remark to which this theory is open is that it seeks and purports to find a *second* source of the heat notoriously proceeding from the interior of the globe towards its surface, and thence into outer space, where one already, *ex hypothesi*, exists fully sufficient for the purpose. This outward escape of heat from within the crust of the globe takes place in three modes, viz.: 1st, probably upon every point of its surface, by conduction through the outer rocks, as proved by the nearly uniform downward increase in temperature, perceptible in borings, wells, mines, and other experimental trials; 2nd, by warm and often very hot springs that rise to the surface; and 3rd, by the escape of still more highly heated water in the shape of steam, and also of fused rocks (lava) in volcanic eruptions. Now Mr. Mallet admits that in the two former of these modes, the escaping heat proceeds from the heated nucleus below; to which loss of heat, of course, he attributes the cooling and consequent shrinking of that nucleus. But to the heat that escapes in the *third* mode—that of volcanic eruptions—he ascribes a totally distinct and independent origin, namely, the conversion into heat of the crushing force to which the subsiding crust is, according to him, subjected. The greater number of hot springs known to physical geographers are, however, unquestionably found in close connexion with volcanoes or volcanic rocks, some welling out from the craters themselves; and it is impossible to suppose that these owe their high temperature to a source wholly different from that of the steam which rises in and from the lava of the adjoining volcanic vent. There is no difficulty in understanding how the great fissures in the solid crust of the globe, which are marked outwardly by *trains* of active, or once active, volcanoes, may penetrate so far into the interior of the heated nucleus as to give vent to an amount of heat sufficient to fuse the rocks through which they pass, and to some of the already fused or viscid underlying matter.

I have more than once explained in the pages of this MAGAZINE, and elsewhere, in what mode it is probable that local inequalities of temperature in the sub-cortical matter of the globe are produced by heat, prevented from escaping through accruing thicknesses of superficial stratified deposits of very low conductivity, accumulating beneath them, and thence being drawn off laterally through the more or less open rents which local variations of temperature, and consequently of volume, must occasion in the matter underlying the crust.[2]

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[1] GEOL. MAG. Vol. X. No. 7, July, 1873.

[2] See GEOL. MAG. July, 1873, and March, 1870; also "Volcanoes," ed. 1862, p. 308, and Mr. H. Woodward's *Presidential Address* to the Geological Association for *1873.*

We are not then compelled to seek for any other source of volcanic heat than that which even Mr. Mallet is obliged to employ as the "primum mobile" of his theory, namely, the heated nucleus itself. Mr. Mallet does not deny that it is to this source the downward increasing temperature of the surface of the globe is owing,—nay, as has been seen, he attributes to it likewise the high temperature of hot springs: why then stop there, and look for another totally different origin in the case of the heat of lava and the steam evolved from it? This second source of heat is plainly not wanted to explain the latter class of phenomena, so closely allied, as I have said above, with the former.

I suspect Mr. Mallet has but an imperfect acquaintance with the phenomena of volcanoes in activity, or he would not speak as he does (§ 190) of the expenditure of heat in the explosions of steam from a volcano in eruption as "not resembling that which takes place from a steam engine, but rather that of powder exploded in a cannon, . . . the loss from which is shown by experiment to be much smaller." The contrary is really the case; the explosions from a volcano in activity resembling precisely in character (and apparently in cause) those of a Perkins steam-cannon fed by a continuous escape of steam from a boiler. Explosions of this character continue in some cases unintermittently for months, and the amount of heat so lost in space must be immense.

Again, Mr. Mallet says (§ 187), "Observations made everywhere on volcanic cones indicate that but a very small proportion of their total mass has been fused; the rest having been merely heated. It is probably below the truth to assume that there are twenty volumes of such heated matter (dust, lapilli, scoriæ, etc.) to one of fused lava." This also is the very reverse of the truth. Of the fragmentary matter ejected by an eruption, at least nineteen-twentieths have been fused, being mere scoriæ, that is, the hardened scum of the boiling lava thrown up by explosions from its surface, and by their repeated fall into the crater and re-ejection, triturated by collision in the air into the "lapilli and dust" of which volcanic ash and conglomerates are mostly composed. Moreover, in any attempt to calculate the heat expended by volcanic eruptions, we ought to take into account not only the mass of the cones themselves (to which Mr. Mallet confines himself), but likewise that probably far larger volume of once fused matter which has been carried away in the form of dust by the winds (or waves) and spread over thousands of square miles of the surrounding areas.

This mistaken view of the origin of "volcanic ash" is the source of a fundamental error in Mr. Mallet's classification of volcanic action into two kinds, which he distinguishes as the "hydrostatic" and the "explosive or *existing* volcanic action," and attributes to them entirely distinct dates in the globe's history. "The commencement," he says (§ 79), "of existing volcanic action . . . . probably does not go back much beyond the end of the Secondary period, *if so far.* Prior to that, Vulcanicity seems to have been *developed in the welling*-up of huge volumes of liquid rock between d masses, or masses of *heated dust*, or *so-called ash*, but with- ₃cta due to elastic steam. . . . . The so-called deposits of ınic ash," the trap-dykes and porphyry-bosses of the Silurian in the south of Ireland and North Wales, etc., are evidences ₃ous action indeed, but of that *hydrostatic* character which ₃d the *explosive* volcanic action of the present epoch.

' there is certainly no reason to suppose the "ash," which is ely developed among the eruptive rocks of Silurian age, to owe ;in or the comminution of its particles to any other cause than hich threw up and triturated the volcanic ash of more recent ions. Mr. Mallet seems to consider the former to have been ed in some obscurely hinted way under-ground (perhaps by shing process), and to have "welled up" some how or other, ır with the "volumes of liquid rock (lava)" by "hydrostatic" re, "without any ejections due to elastic steam." The notion ı a process is not merely without reasonable foundation, but ed unintelligible. That some of the plutonic crystalline rocks ıd up" in a more or less liquefied state, through fractures in ust, unaccompanied by explosive ejections of scoriæ or ash, ıly probable, and seems proved by the absence of beds of such ıntary character in their neighbourhood. Such eruptions ıs took place mostly under the ocean, the weight of water the vent preventing the outward explosion of steam bubbles. ; is probable that similar formations are even now going on submarine volcanoes. But that the explosive and "hydro- ' action of volcanoes belongs severally to different eras of the ı history, the one "earlier than the end of the Secondary age," ıer beginning then and extending to our own time, is wholly ıary, and contradicted by indisputable geological facts.

ı unauthorized notion of the existence of vast masses of "dust" h the earth's crust pervades much of Mr. Mallet's theoretical ıf the cause of "hypogeal disturbances." He speaks of the of the ocean above penetrating through crevices to such masses ushed and crumbled rock at a red heat," filtering through as water does through red-hot sand in our furnaces (§ 211), 'entually boiling up as "boursoufflé lava."

this is of course mere conjecture.

se examples are given here to show how imperfect are the data ich Mr. Mallet bases his calculations as to the amount of heat y the globe through the action of its volcanoes. But the data rming any opinion on the opposite side of the proposed on—viz. the amount of heat produced by the crushing of the composing the solid crust of the earth through their subsidence ravitation towards a shrinking nucleus—are of a character still vague and uncertain; so much so, indeed, as to render any ıtion upon them perfectly illusory. What reliable measure ı obtained of the rate of cooling of the heated nucleus of the ? of its consequent shrinkage? of the crushing force thus d on the more or less solid *crust*, or the amount of heat thereby *ped? Calculation is wholly* out of place where the data on which it proceeds consist of such unascertainable quantities. For example, take Mr. Mallet's experiments on the crushing force of various rocks. These will, no doubt, be valuable to architects and engineers; but, being made upon small cubical blocks in a dry state, at the temperature of 57°, and subject on four of their sides to no other resistance than that of the atmosphere, are wholly inconclusive as to the effect of pressure on similar rocks miles under ground, permeated with water, at temperatures probably far exceeding 1000°, and in contact on all sides with resisting media at least as unyielding as themselves. Moreover, the effect of pressure upon mineral matter at exceedingly high temperatures in raising or lowering their fusing points is, from the difficulty of conducting the experiments, as yet, I believe, extremely obscure. And this additional source of uncertainty is not touched upon in Mr. Mallet's investigations.

Mr. Mallet's further experiments on the contraction of rock matter in passing from a state of liquid fusion to one of solidity by loss of heat are useful, as reducing the probably exaggerated estimates of Bischoff, who set down the loss of volume in granite on cooling at nearly one-fourth, while Mr. Mallet places that of basic slag-matter at about six per cent., and of acid silicates at considerably less. But Mr. Mallet himself adds that "*as applied to our globe* it is highly probable that any inferences that may be drawn from these experiments must be subject to the changes in volume that may have arisen as the mass cooled from changes in its molecular arrangement, such as that from the vitreous to the crystalline condition, *data for which are unknown*" (§ 173).

All then that Mr. Mallet is entitled to say is that, on the hypothesis of a gradually cooling globe, *some* portion of the heat which is sensibly perceived to escape from its interior by conduction through the superficial rocks, and convection by means of hot springs and volcanic eruptions, may possibly be generated by the compression or crushing of the crust as it follows the shrinking nucleus. Any attempt to measure the amount of heat produced in this manner, and to compare it with that which directly proceeds from the transmission outwardly of the original heat of the interior, is, I think, in the present state of our knowledge of that interior, and of the forces acting there, unprofitable, or at all events premature. Indeed, Mr. Mallet himself admits (§ 181) that "we are obliged by the phenomena of hypogeal temperature to conclude that *by far the largest proportion* of the heat annually lost *reaches the surface from a cooling nucleus.*" Where then, I ask, is there any evidence that the remaining fractional portion of this heat is really produced by compression of subsiding rock, and is "the true source of volcanic energy," as Mr. Mallet maintains it to be?

Mr. Mallet's theory fails, I think, to account for the fact that volcanic eruptions are almost wholly confined to certain lines or bands traversing the earth's surface, and apparently indicating the [illegible]istence through long geologic ages of great rents in the solid crust, [illegible] *direction of* which is generally parallel to the coast outlines of the continents or the axes of their mountain ranges. If we suppose these continents to be the result of the unequal subsidence of large reas of the crust, some remaining at high, others sinking to lower levels, and forming the oceanic basins, it is intelligible that along the bounding lines separating the sunken from the elevated areas, rents hould have been formed[1] deep enough in some places to give ssue to some of the heat and mineral matter still in a fused or iscous state beneath—rents which every subsequent disturbance of he adjacent areas would probably deepen or enlarge, occasioning a ore or less interrupted sequence of eruptions. But it is not easy o understand why, on Mr. Mallet's theory of the source of volcanic nergy, its development should be confined to these circa-continental ands. It would seem more likely that intense crushing of the ubsiding rocks and consequent production of heat would occur niformly at every point of the spherical envelope; or, if anywhere t a maximum, that this would be beneath the centres of elevated reas, rather than on their outer limits; on which supposition he once fused plutonic masses which so often form the axial ortions of elevated ranges, and throw off on either side the uperficial strata, may owe their expansion and rise in part to the eat proceeding from the extreme crushing force concentrated at hose points. Yet even as regards these eruptive rocks, the orphyries, granites, serpentines, etc., the presumption would seem to e that their swelling up was owing to the expansion occasioned by n increased flow of heat *from beneath* into the crystalline and semi-lastic subterranean matter, causing it to fracture and force up the verlying beds of rock, and sometimes even to overflow the surface.

With regard to the modes in which volcanic heat, however originated, operates in fusing or liquefying portions of subterranean rock, forcing it in this state up more or less deep and narrow fissures, and expelling it on the surface as lava, or steam-ejected scoriæ, etc., Mr. Mallet's views are neither original, nor, indeed, consistently reasoned out. He follows those geologists, Lyell, etc., who consider eruptions to be occasioned by the influx of water from seas or lakes above through fissures into foci of heated lava below. And he rejects as wholly untenable the notion that water could have originally existed in molecular combination with the crystalline matter of the rocks before they were melted into lava. Yet he admits that there is no limit to the depth to which water may infiltrate by capillarity into the subterranean rocky matter, and that portions of this so permeated with water may have been fused and reconsolidated again and again. So also he ridicules the idea, which he ascribes to Hopkins, of the existence of subterranean lakes, or local reservoirs of lava. Yet he himself supports that of separate foci, or localized portions of melted rock at different points and depths within the volcanic fissure;[1] which seems to be much the same thing, and is certainly no original idea. Again, Mr. Mallet contumeliously rejects the common notion that volcanic eruptions act as "safety-valves" to the force which would otherwise produce destructive earthquakes.[2] Yet he himself argues that his crushing mechanism for producing the heat at intervals, which gives rise to volcanic eruptions, obviates the occurrence of paroxysmal "Cataclysms" which would probably destroy all living things upon the globe's surface. And what can be meant in this connexion by "Cataclysms" but earthquakes of tremendous violence?

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[1] Such rents may be compared to those produced along the edges of a sheet of ice on a pond or river, from which the water beneath has been lowered in level; or still more closely to those lateral rents formed in a sheet of lava as its interior subsides on cooling, or escapes laterally, of which the *Almanayia* in Iceland is a typical example. See "Volcanoes," *ed. 1862, p. 77.*

Mr. Mallet claims for his theory the special merit of explaining the intermittent action of volcanoes, as well as the shifting of the active vents from one point to another of the main volcanic bands (§ 218). But these characteristics of volcanic action have been far more reasonably accounted for by the fact that the violent discharge of steam and lava during an eruption exhausts the energy of a volcano for a time; the lava sinking within the vent, and through the outward loss of heat cooled down and caked over with a solid crust, which for a time resists any further expansion by decrease of heat from below—perhaps even seals up the vent so firmly that the intumescent lava and vapour find an easier issue in some other more or less distant and weaker point of the main line of fracture (See Volcanoes, p. 41 *et seq.*, 228, etc.)

On the whole, while I admit the plausibility of Mr. Mallet's suggestion that some local development of heat must attend the crushing and squeezing of rocky matter during the internal movements to which their fractures and contortions, as well as the slaty cleavage of many, prove them to have been subjected, it appears to me that the phenomena rather indicate as the true source of the heat which has evidently occasioned the eruptions of both plutonic crystalline rocks and of volcanic lavas, that intensely heated interior (or nucleus), the existence of which is the first postulate of Mr. Mallet's own theory. And to the lateral shifting of the wave of heat outwardly transmitted from this source,—shifting caused by the varying impediments offered to the outward escape of this heat by conduction through superficial deposits,—I prefer to ascribe the internal movements that are observable alike in earthquakes and volcanoes, in elevations and depressions of the crust, and extravasations of the internal heated matter.

NOTICES OF MEMOIRS.

On the Geological Conditions affecting the Construction of a Tunnel between England and France. By Joseph Prestwich, F.R.S., F.G.S., Assoc. Inst. C.E.

Being the substance of a paper read before the Institution of Civil Engineers on Tuesday, December 9th, 1873. T. Hawksley, Esq., President, in the Chair.

THE author, in this paper, reviewed the geological conditions of all the strata between Harwich and Hastings on one side of the Channel, and between Ostend and St. Valery on the other side, with a view to serve as data for any future projects of tunnelling, and to show in what directions inquiries should be made. The points considered were the lithological characters, dimensions, range and probable depth of the several formations. The London-clay, at the mouth of the Thames, was from 200 feet to 400 feet thick, while under Calais it was only 10 feet, at Dunkirk it exceeded 264 feet, and at Ostend it was 448 feet thick. He considered that a trough of London clay from 300 feet to 400 feet, or more, in thickness, extended from the coast of Essex to the coast of France, and, judging from the experience gained in the Tower Subway, and the known impermeability and homogeneity of this formation, he saw no difficulty, from a merely geological point of view, in the construction of a tunnel, but for the extreme distance—the nearest suitable points being 80 miles apart. The Lower Tertiary strata were too unimportant and too permeable for tunnel work. The Chalk in this area was from 400 feet to 1000 feet thick; the upper beds were soft and permeable, but the lower beds were so argillaceous and compact as to be comparatively impermeable. In fact, in the Hainault coal-fields they effectually shut out the water of the water-bearing Tertiary strata from the underlying Coal Measures. Still, the author did not consider even the Lower Chalk suited for tunnel work, owing to its liability to fissures, imperfect impermeability, and exposure in the Channel. The Gault was homogeneous and impermeable, but near Folkestone it was only 130 feet thick, reduced to 40 feet at Wissant, so that a tunnel would hardly be feasible. The Lower Greensands, 260 feet thick at Sandgate, thinned off to 50 feet or 60 feet at Wissant, and were all far too permeable for any tunnel work. Again, the Wealden strata, 1200 feet thick in Kent, were reduced to a few unimportant rubbly beds in the Boulonnais. To the Portland beds the same objections existed as to the Lower Greensands, both were water-bearing strata. The Kimmeridge-clay was 360 feet thick near Boulogne, and no doubt passed under the Channel, but in Kent it was covered by so great a thickness of Wealden strata as to be almost inaccessible; at the same time it contained subordinate water-bearing beds. Still, the author was of opinion that, in case of the not improbable denudation of the Portland beds, it might be questionable to carry a tunnel in by the Kimmeridge-clay on the French coast, and out by the Wealden beds on the English coast. The Oolitic series presented conditions still less favourable, and the lower beds had been found to be water-bearing in a deep Artesian well recently sunk near Boulogne. The experimental deep boring now in progress near Battle would throw much light on this part of the question.

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[1] § 114.

[2] § 221.

The author then passed on to the consideration of the Palæozoic series, to which his attention was more particularly directed while making investigations, as a member of the Royal Coal Commission, on the probable range of the Coal Measures under the South-East of England. He showed that these rocks, which consisted of hard Silurian slates, Devonian and Carboniferous Limestone, and Coal Measures, together 12,000 feet to 15,000 feet thick, passed under

the Chalk in the North of France, outcropped in the Boulonnais, were again lost under newer formations near to the coast, and did not reappear until the neighbourhood of Frome and Wells was reached. But, although not exposed on the surface, they had been encountered at a depth of 1032 feet at Calais, 985 feet at Ostend, 1026 feet at Harwich, and 1114 feet in London. They thus seemed to form a subterranean table land of old rocks, covered immediately by the Chalk and Tertiary strata. It was only at the southern flank of this old ridge that the Jurassic and Wealden series set in, and beneath these the Palæozoic rocks rapidly descended to great depths. Near Boulogne these strata were already 1000 feet thick; and at Hythe the author estimated their thickness might be that or more. Supposing the strike of the Coal Measures and the other Palæozoic rocks to be prolonged from their exposed area in the Boulonnais across the Channel, they would pass under the Cretaceous strata somewhere in the neighbourhood of Folkestone, at a depth estimated by the author at about 300 feet, and near Dover at about 600 feet, or nearly at the depth at which they had been found under the Chalk at Guines, near Calais, where they were 665 feet deep. These Palæozoic strata were tilted at high angles, and on the original elevated area they were covered by horizontal Cretaceous strata, th
basement beds of which had filled up the interstices of the olde
rocks as though with a liquid grouting. The overlying mass o
Gault and Lower Chalk also formed a barrier to the passage o
water so effectual, that the Coal Measures were worked withou
difficulty under the very permeable Tertiary and Upper Chalk
the North of France; and in the neighbourhood of Mons, notwit
standing a thickness of from 500 feet to 900 feet of strata charge
with water, the Lower Chalk shut the water out so effectually th
the Coal Measures were worked in perfect safety, and were found
be perfectly dry under 1200 feet of these strata combined. N
part of the Straits exceeded 186 feet in depth. The author, ther
fore, considered that it would be perfectly practicable, so far
safety from the influx of the sea-water was concerned, to drive
tunnel through the Palæozoic rocks under the Channel betwee
Blanc Nez and Dover, and he stated that galleries had actually bee
carried in coal, under less favourable circumstances, for two mil
under the sea near Whitehaven. But while in the case of t
London clay the distance seemed almost an insurmountable bar, he
again the depth offered a formidable difficulty. As a collater
object to be attained, the author pointed to the great problem
the range of the Coal Measures from the neighbourhood of Calais i
the direction of East Kent, which a tunnel in the Palæozoic stra
would help to solve. These were, according to the author, t
main conditions which bore on the construction of a submari
tunnel between England and France. He was satisfied that
geological grounds alone, it was in one case perfectly practicabl
and in one or two others it was possibly so; but there were oth
considerations besides those of a geological nature, and whether
not they admitted of so favourable a solution was questionable. I

any case, the author would suggest that, the one favourable solution admitted, it might be desirable, in a question involving so many and such great interests, not to accept an adverse verdict without giving all those considerations the attention and deliberation which the importance of the subject deserved.

Granting the possibility of the work in a geological point of view, there were great and formidable engineering difficulties; but the vast progress made in engineering science during the last half century led the author to imagine that they would not prove insurmountable, if the necessity for such a work were to arise, and the cost were not a bar.

REVIEWS.

◆

I.—The Coal Regions of America: their Topography, Geology, and Development. With a Coloured Geological Map of all the Coal Regions, and numerous other Maps and Illustrations. By James Macfarlane, A.M. Royal 8vo. pp. 680. (New York: D. Appleton & Co. London: Trübner & Co. 1873.)

MR. MACFARLANE'S work forms a most important addition to the geological literature of coal, and being well posted up as regards all the latest Reports of the Government Surveys, conducted by the best geologists in the United States, it may be looked upon as a most valuable addition to, and even as superseding, to a great extent, those works on the subject published some years since—such, for instance, as Taylor's "Statistics of Coal," and Prof. Rogers' "Geology of Pennsylvania."

The author points out that in America, as in this country, both anthracitic or steam coal and bituminous coals occur; but the comparative abundance is very different, as is also the relative distribution.

By far the most important and the best known coal, says Mr. Macfarlane, is anthracite. It is the universal fuel for domestic use in the United States, in preference to all other kinds of coal (p. 7). The largest area for this coal is that of the Anthracite Coal-fields of Pennsylvania, the total extent of which is 472 square miles, having an average thickness of 100 feet of coal.

The other regions, as the first or Alleghany Coal-field, the Pennsylvanian bituminous regions, the semi-bituminous coal regions of Blossburg, etc. (which latter, with 53 working companies, produced in 1871 a yield of 2,714,790 tons), the bituminous coal regions of Western Pennsylvania, Maryland, West Virginia, Ohio, Eastern Kentucky, Tennessee, Alabama, Michigan, Indiana, Illinois, Western Kentucky, Iowa, Nebraska, Missouri, Kansas, Arkansas, and Texas, are treated at considerable length, carefully prepared sections and maps being furnished to each area, showing the extent and thickness of the seams.

Chapters are also devoted to the Triassic Coal of Virginia and North Carolina; the Cretaceous Coal of the Rocky Mountains, Colorado, Wyoming Territories, and the Pacific Coast; besides the *extension of the Carboniferous series* into Canada and Nova Scotia.

Great as is the area of the Coal-formation in the United States, yet thirteen out of the thirty-seven States composing the Union contain no coal whatever of any kind.

"There are, therefore, very extensive districts in the United States destitute of Coal, and many of them the most thickly populated and the largest consumers of fuel.

"Of the various Coal-fields, four deserve special notice. The first of these is the Appalachian, or, more properly, the Alleghany, and is of continental dimensions, being 875 miles in length, and extending through important parts of seven States in a N.E. and S.W. direction, from 30 to 180 miles wide, and producing a great variety of the best qualities of coal.

"The second Coal-field occupies the central part of the State of Michigan; but, although of large area, the seam is thin and of poor quality.

"The third great Coal-field is of enormous dimensions, covering two-thirds of the large State of Illinois, the western part of Indiana, and the western part of Kentucky. Though inferior in quality to the best coal of Pennsylvania, it is abundant and cheap.

"The same remark applies to the fourth Coal-field, which covers the south-western part of Iowa, the best portions being along the Des Moines River. It also extends southwards, over a large area, in northern Missouri, and into the eastern part of Kansas, the seams being generally thin in all these States.

Maryland sends annually 2,000,000 tons of coal out of its boundaries, Virginia 250,000, Ohio ships 500,000, Pennsylvania mined in 1871 about 24,000,000 tons, of which 15,000,000 tons were anthracite and 9,000,000 tons of various qualities of bituminous coals.

Having regard to the enormous area of the Coal-fields of the United States, containing in all 192,000 square miles, besides the lignites of the Far West, the vast quantity, great variety, accessibility, and wide distribution of their stores of coal, which, up to the present time, have hardly been developed to any really great extent, it is, as the author justly observes, the manifest destiny of America soon to become the greatest coal-producing country in the world.

The following table shows the relation between area and production of the various Coal-producing countries of the world (given on p. 674 of Mr. Macfarlane's admirable work).

Coal-producing Countries.	Area in Sq. M. of Coal-fields.	Date.	Tons.	Per cent. Production.
The United States	192,000	1872	41,000,000	18·66
Nova Scotia	18,000	1871	673,242	0·31
Great Britain	11,900	1871	117,352,028	53·41
France	1,800	1867	12,148,223	5·54
Belgium	900	1871	13,671,470	6·23
Prussia	1,800	1869	26,774,368	12·19
Austria	1,800	1862	4,525,783	2·02
Spain	3,000	1869	593,033	·27
Chili, Australia, India, China, etc.	28,800	1872	3,000,000	1·37
Totals	260,000		219,738,147	100·

II.—On Coal at Home and Abroad with Relation to Consumption, Cost, Demand, and Supply, etc., etc. By J. R. Leifchild, M.A. 8vo. pp. 142. (London: Longmans, Green & Co., 1873.)

MR. LEIFCHILD'S book "On Coal at Home and Abroad" consists of three articles originally contributed to the "Edinburgh Review" in 1860, '67, and '73; the first "On the Coal-fields of North America and Great Britain," the second "On Fatal Accidents in Coal-mines," and the third "On the Consumption and Cost of Coal."

Taking the last article first, the author inquires into the causes of the increased consumption and consequent advanced price of this important commodity. Mr. Leifchild shows that the great increase is due to the rapid general extension of our national industries, the return of prosperity after a weary interval of depression, and a revival of some particular industries which require a large supply of coal.

The chief of these are the production of iron, copper, lead and other metals; our cotton and woollen manufactures also absorb a considerable quantity; besides which the various forms of steam-power now make a very large demand upon the extraction of coal; thirty millions of tons being the annual requisite for all steam purposes in manufactures and navigation.

The manufacture of gas for lighting probably consumes one-ninth of all the coal raised, whilst the domestic consumption may amount in round numbers to twenty millions of tons; which, according to the present increase of the population, would require an addition of one million of tons every five years.

"From the continual operation of these combined causes, the reader will be prepared to credit the astonishing progress of coal extraction in the last few years. If we begin with the sixty-five millions of tons extracted in 1857, and pass to the seventy-two (nearly) millions extracted in 1859, thence proceeding to the ninety-eight millions of tons in 1865, we may advance at once to the one hundred and seventeen millions of tons raised in 1871.

"It is therefore manifest that we have increased our coal extraction by about fifty-two millions of tons in fifteen years, and that the increased extraction during that period approximates to the total annual extraction of the first year.

"Furthermore it seems highly probable that under present causes, our total coal extraction will, in five years hence, be at least one hundred and thirty millions of tons for the year, in which case the entire coal production of Britain will have doubled itself within twenty years." (p. 11.)

"Not only are we called upon to meet the wants of our own busy land, but several countries have made considerable calls upon our coal-resources, and are continually increasing their demands, insomuch that our present exports of coal are nearly four times as large as they were twenty years ago.

"France is the largest *foreign consumer* of our coal, and the *gradual growth of the exports to that* country is truly remarkable.

In 1812 we gave France a small quantity of coal. In 1822, however, we sent there 31,000 tons; in 1832 we exported as much as 37,000 tons; and in 1842 no less than 490,000 tons. Advancing to 1852, the birth of the Second Empire, France obtained from us 652,000 tons. In 1862 it was found that the growth of manufacturing industry was so considerable that it had enlarged the coal demand of France upon us to 1,306,255 tons; while, in 1872, it rose to 2,191,340 tons!" (p. 13.)

France has greatly increased her own coal-extraction, but she will not lessen her drain upon our resources. Germany also is a consumer of English coals, but in a less degree than France. South America took one million of tons, and Russia three-quarters of a million of tons of coal, in 1872.

"The total amount of coal shipped by us last year to foreign countries was 12,092,000 tons, showing an increase of 302,027 tons over the shipments of the previous year, and every year our exports have been increasing, although it was thought in 1869 that we had surely arrived at a maximum when we shipped nearly ten and a half millions of tons, and including coke and anthracite, actually 10,837,804 tons!" (p. 14.)

In briefly noticing the causes so clearly brought forward by Mr. Leifchild for the increased consumption of coal, there are others also alluded to which at present operate to diminish the downward tendency of the cost of production, such as advanced wages, larger profits, and increased exports. The latter is a difficult subject for legislation, seeing that it clashes with private interests and interferes with our free trade policy; still it is of the utmost importance when we take into consideration the general quality of the coal exported and the effects arising therefrom. We have long advocated a restrictive duty on exported coal because the coal-fields yielding two of our very best and most valuable kinds of fuel, namely, Household and Steam Coal, such as are furnished by the Newcastle-upon-Tyne District on the one hand, and the South Wales Coal Field on the other, are peculiarly favourably situated for easy shipment. Moreover it is a well-known fact that good as is some of the coal of the Lancashire and Midland Counties, the coals of the Northern District are considered of better quality, and realize in our own markets the highest price, whilst the South Welsh coal is most valuable for our steam navy.

The export therefore of so large a part of our best fuel to countries less favoured than ourselves enables them in part to husband their more limited resources for future times, when the same amicable relations between ourselves and other countries might not exist.

It is moreover a source of exhaustion, and taking into consideration our own rapidly increasing coal-requiring population, it is of the highest political importance that we should look to our home-interests first.

With an advanced price of coal our industries must be to some extent paralysed, especially if, from our isolated position, we should *ever become as a nation, importers* instead of exporters of coal.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—November 19, 1873.—Professor Ramsay, F.R.S., Vice-President, in the Chair. The following communications were read:—

1. "Supplemental Note on the Anatomy of *Hypsilophodon Foxii.*" By J. W. Hulke, Esq., F.R.S., F.G.S.

The material for this note was a slab from Cowleaze Chine, containing portions of two individuals of *Hypsilophodon Foxii*, one consisting of a skull with a great part of the vertebral column, the other of a portion of the vertebral column. The author described some details of the structure of the skull, and especially the palatal apparatus. The pterygoids, which are not mesially joined, have a stout body, the posterior border of which bears a very large basisphenoidal process, and the left pterygoid retains the root of a strong quadratic process, in front of which the hollow outer border runs out into an ectopterygoid. In front of the pterygoids the palatines are partially visible, also separated by a fissure. Of the eight vertebræ, the three last are firmly anchylosed, and the seventh and eighth form part of the sacrum. They are constricted in the middle, and their transverse processes, which spring from the junction of two vertebræ, are bent backwards, joining the dilated outer end of the transverse processes of the next vertebra, including a large subcircular loop. The second fragment of a vertebral column, which belonged to a smaller individual, includes the sacrum and several vertebræ. Near the skull the slab contains several very thin bony plates of irregularly polygonal form, regarded by the author as dermal scutes. In connexion with the question of the generic rank of *Hypsilophodon*, the author stated that in *Hypsilophodon* the centra of the sacral vertebræ are cylindroid, and rounded below, whilst in *Iguanodon* they are compressed laterally and angulated below.

DISCUSSION.—Mr. Boyd Dawkins thought there was as much distinction between *Hypsilophodon* and *Iguanodon* as between *Hipparion* and *Equus*, and that this was quite sufficient to be regarded as generic rather than specific. He was not satisfied as to the additional bone in the foot in Mr. Beccles's specimen, but thought it might belong to some other part of the animal. He did not accept the received view as to the character of the upper teeth of *Iguanodon*.

Mr. Seeley considered that the author was likely to substantiate his opinions. He pointed out certain differences in the structure and form of the maxillary and other bones of the skull in *Hypsilophodon* and *Iguanodon*, and especially in the maxillary. He attached great importance to the thickening of the enamel at the base of the teeth of *Hypsilophodon*, which approximated to that which was found in some mammals. The teeth commonly reputed to be those of *Iguanodon* might, he thought, belong to different species, if not genera, and showed some divergence in character. The observations on the palatal bones of *Hypsilophodon* were, he thought, calculated to throw great light on the anatomy of Dinosaurs.

2. "The Drift-beds of the North-west of England.—Part 1. Shells of the Lancashire and Cheshire Low-level Boulder Clay and Sands." By T. Mellard Reade, Esq., C.E., F.G.S.

The author commenced by explaining a section in a cutting at Bootle Lane Station in which most of the beds seen about Liverpool are typically represented. This section shows in ascending order:—1. Pebble-bed of the Trias; 2. shattered rock; 3. compacted red sand and rubble (ground moraine); 4. lowest bed of Boulder-clay (largely composed of red sand); 5. stratified sand, with shell-fragments; 6. bed of fine unctuous clay; 7. brick-clay (with many shells and striated boulders); 8. sand-bed; 9. stratified yellow sand ("washed-drift sand").

The author next gave a list of the localities in which shells were found, and stated that in all forty-six species had been met with distributed through the clay-beds,—those found in the sand-seams being rare,—and generally fragmentary and rolled. The shells most commonly found entire are usually of small size, and of a form calculated to resist pressure,—such as *Turritella communis, Trophon clathratus,* and *Mangelia turricula.* *Fusus antiquus* and *Buccinum undatum* are generally represented only by worn fragments of the columella, and *Cyprina Islandica* is always found in fragments. The author thought that the association of the various species distributed without order through the clays shows that they could not have lived together on the same bottom, but that they must have been to a great extent transported. He contended that the admixture of shells in the Boulder-clay was due to the tendency of the sea to throw up its contents on the beach, whence changing currents and floating ice might again remove them, and to the oscillations of the land bringing all the beds at one time or another within reach of marine erosive action. He maintained that it is in the distribution of land and sea at the period of deposition of the Lancashire deposits, and not in astronomical causes, that we must seek the explanation of the climate of that period, the conditions of which he endeavoured to explain by a consideration of the proportions of the species and the natural habitats of the shells found in the drifts.

3. "Notes on a Deposit of Middle Pleistocene Gravel near Leyland, Lancashire." By R. D. Darbishire, Esq., F.G.S.

The bed of gravel, about 40 feet thick, and about 240 feet above the level of the sea, is covered by yellow brick clay, and overlies an untried bed of fine sea-sand. The shells and fragments occur chiefly at the base of the gravel.

The most noticeable shells in the list of forty-two species, collected by Miss M. H. Farington, are *Panopæa Norvegica, Mactra glauca, Cytherea chione, Cardium rusticum, Fusus propinquus* and *Fusus antiquus,* var. *contrarius.* One specimen of *Fusus craticulatus* occurred.

The group is by no means characteristically Arctic or Glacial. It represents most nearly the Wexford lists, especially in presenting the reversed *Fusus,* and may be considered as connecting those beds with the Macclesfield drifts, also containing a Celtic assortment, with *Cytherea chione* and *Cardium rusticum.*

The author considered the Leyland deposit, like those on the west of the Derbyshire hills, to be more probably littoral and truly climatic than that of the Liverpool clays, the subject of Mr. Reade's paper, and hazarded the conjecture that the latter were sea-bottom beds, into which, during some process of degradation and redistribution, the specimens found and enumerated by Mr. Reade had been carried down from the former more ancient retreating coast-lines.

DISCUSSION.—Mr. Darbishire was not prepared to accept the view of the shells in the drift having existed on the spots where now found. He thought rather that the fragmentary remains might have been derived from the destruction of earlier beds deposited under somewhat different conditions. The occurrence at Wexford of nearly similar beds to those at Leyland pointed to a great destruction of an old sea-shore.

Mr. Gwyn Jeffreys thought that all the shells found in these Lancashire beds were just such as might have been thrown up on the shore, though the matrix in which some of them are found is not sandy. The *Trophon* discovered was *T. truncatus*, and not *T. clathratus*. Neither was he quite satisfied that Miss Farington's *Fusus* was really *F. craticulatus*. The occurrence of *Fusus antiquus*, monstr. *contrarius*, did not surprise him, though that of *Mactra glauca* was very remarkable. He did not believe in the retiring or voluntary migration of mollusca, though they might be transported by currents or driven away by want of food. He did not regard any of the shells as truly Arctic, and doubted whether any of them afforded clear evidence of climatal conditions.

Mr. Prestwich remarked on the progress which had been made in our knowledge of these shells since Sir P. Egerton had first called attention to the drift in which they occur. The number of perfect specimens from Leyland was, he thought, very striking. He had some difficulty in following Mr. Reade into the large theoretical questions into which he had entered, but pointed out that the striation of the surface of the country was significant of a period of intense cold, for which any alteration in the arrangement and proportions of land and water could hardly account. But in the overlying Boulder-clay the fragments of shells were all of species still existing in the neighbouring seas of the present day, and he did not think that at the time of its deposit the climate was of necessity intensely cold.

Prof. Hughes did not think that the deposits were in any way immediately connected with the Boulder-clay, to which they were long subsequent. He rather correlated them with the Hessle and Kelsey beds of the East coast. The deposits might in many cases have been formed on the shore of a sea which was eroding a cliff of Boulder-clay; and by this means there would be an admixture of the more recent shells with the redeposited boulders from the older clay. He submitted that the shells belonged to an age succeeding the true Glacial period. In the higher deposits there were still some traces of the more Arctic forms, while a more southern facies came over the fauna of the lower beds.

Mr. Charlesworth observed on the possibility of the transport of shells in the stomach of fishes. As to the comminuted condition of *Cyprina Islandica*, he remarked that in the Crag beds these shells are nearly always much cracked, even when delicate shells in the neighbourhood are perfect.

The Chairman was glad that the old view as to the successive elevations and submergences during the Glacial period was not likely to be disturbed. As to the physical causes which conduced to the extreme cold, he did not undervalue the changes in physical geography; but if the astronomical causes, the existence of which seemed now to be fairly established, would have produced the effects, he did not see why they should be ignored even if the geographical causes might suffice. These latter seemed to be at best theoretical, whereas the former seemed mathematically necessary. He was not inclined to detach the shells from the clay, and thought that during the time of their deposit there were still glaciers on the higher points of the land. He did not agree with Prof. Hughes in regarding the beds with striated pebbles in the Vale of Clwyd as Post-glacial, and could not believe that in the case of the reconstruction of the beds the striæ could be preserved and the pebbles not become smooth.

Mr. Reade, in reply, stated that his observations were intended to apply merely to the conditions under which the beds containing the shells had been deposited, and not to the period of extreme cold, for which he was quite willing to admit the potency of astronomical causes. He agreed with the Chairman in regarding the clay as a real Boulder-clay, the pebbles in it being for the most part scratched.

CORRESPONDENCE.

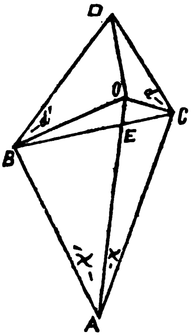
SUGGESTIONS FOR GEOLOGICAL SURVEYORS.

SIR,—The following proposition will, I venture to think, be *found* very useful to Geological and Mining Surveyors, for none of the text-books give any information on the subject. I hope, therefore, that you will be able to find room for it. F. W. HUTTON.

WELLINGTON, NEW ZEALAND,
6th August, 1873.

Given the dip on each side of an anticlinal or synclinal curve, to find the direction of the axis.

(*a.*) To find the bearing of the axis.



Let OC and OB represent the bearings of the two dips. From O erect the vertical OD. Make the angles OCD and OBD equal to the dip on each side of the curve. Draw CA at right angles to OC, and BA at right angles OB. Join AO and BC. Then CA and BA represent the strike of the beds on each side, and AO represents the bearing of the axis.

Let $\angle OCD = d$; $\angle OBD = d'$; $\angle OAC = x$; $\angle OAB = x'$; and $\angle BAC = A = x + x'$.

Then because OBE and CEA are similar triangles $\angle OBC = x$; and for the same reason $\angle OCE = x'$.

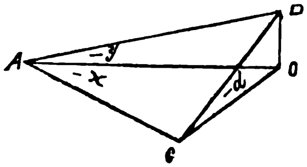
Also $CO = DO \cot d$
and $BO = DO \cot d'$.

Consequently

$$\tan \tfrac{1}{2}(x' - x) = \frac{(\cot d' - \cot d) \tan \frac{1}{2} A}{\cot d' + \cot d.}$$

by which x, and therefore the bearing of the axis, can be found.

(*b.*) To find the inclination of the axis.



Let, as before, AC represent the strike, and DCO the angle of dip (d) of the beds on one side of the curve. Join AD. Then AO represents the bearing of the axis, and DAO is its inclination to the horizon. Let $\angle DAO = y$.

$$\text{Then } \tan y = \frac{DO}{AO}.$$

$$DO = OC \tan d$$

$$AO = OC \operatorname{cosec} x$$

$$\therefore \tan y = \frac{\tan d}{\operatorname{cosec} x} = \tan d \sin x.$$

which gives the inclination of the axis with the horizon.

N.B.—The axis of an anticlinal curve will incline *downward* towards the angle formed by the two lines of strike, while the axis of a synclinal curve will incline *upwards* towards that angle.

THE UPPER INDUS BASIN.

SIR,—Under this heading in the August Journal of the Geological Society, Mr. Drew gives us an excellent collection of facts admirably illustrated with drawings. In theorizing on these facts Mr. Drew supports throughout the view which I had the honour to advance in the GEOLOGICAL MAGAZINE (Vol. IV. 1867, p. 205), under the head of "Valley Terraces," namely, that the parallel terraces are the remains of river alluviums, and that they are not, as is generally held, shores of ancient lakes, or due to marine action, as is also argued. But beyond this, Mr. Drew's facts cut entirely against his own theories. That is, his facts prove that rain and rivers have made, and are still making, his side "fans," main river alluviums and terraces, and that these are not (according to his theory) due to the glacial epoch (page 470), or to any former "different state of climate" (page 457). His facts also demonstrate that these *inland* patches of river alluviums (which are not to be confused with those open to the *sea*) are due to what Mr. Mackintosh has called "Colonel Greenwood's hard gorge and soft valley theory." Every one of Mr. Drew's flat alluviums is immediately above a hard gorge. And this immediate alternation of gorge and flat alluvium is found not only in the Indus valley, but throughout the wide wide world, wherever a river crosses strata of different hardness. Directly as the strata are hard is the narrowness of the gorge which the river cuts. This gorge the river has difficulty to deepen, and atmospheric disintegration and the erosion of rain have difficulty to widen. But throughout the soft strata above the hard gorge the river cuts its bed flat at the level of the gorge, and the atmosphere and the rain easily make and widen a flat valley. The water of every rain flood is then checked at the narrow gorge, overflows the flat valley, and deposits an annually increasing alluvium on it. But as the alluvium rises by deposit, the bed of the gorge (and consequently of the river above) sinks from erosion, and the time comes when the river can no longer overflow. The confined flooded river then tears down the soft alluvial banks of its own building, and eats them away to the hill-sides, where they remain as parallel terraces. A new flat and a new alluvium is then begun at the new level of the gorge. This process has been repeated for what man may call an eternity of time. It is still going on with unabated vigour, and will continue to go on as long (as Mr. Drew says) "as there are mountains behind to waste."

This is the simple "open Sesame" of Mr. Drew's puzzle (p. 469), "to account for rivers and streams being at one time denuders, at another accumulators, and at a third time denuders again—in other words, to discover why these streams shall at one time lower their beds, cutting down through the rock, at another raise them by depositing alluvium and rising upon it, and at last again lower their beds by cutting down through that alluvium."

BROOKWOOD PARK, ALRESFORD, GEORGE GREENWOOD, Colonel.

FURTHER DISCOVERY OF REMAINS OF A GREAT EXTINCT WINGLESS BIRD IN AUSTRALIA.

SIR,—In the GEOLOGICAL MAGAZINE for 1869. Vol. VI. p. 383, will be found a letter from the Rev. W. B. Clarke. F.G.S., St. Leonard's. New South Wales. giving an account of the discovery of the femur of a bird resembling *Dinornis*. found in sinking a well at Peak Downs. Queensland. The bone in question was submitted to me. and I pronounced it to be the femur of a bird about the size of *Dinornis robustus*.

Since then I learn that Prof. Owen has described it. from a *cast*[1] which I had prepared and forwarded to him. as *Dinornis* (*Dromornis?*) *Australis*.[2] in the Zoological Transactions for 1873. vol. viii. part vi.

And here let me state that the mineralized condition of this bone is precisely that of hundreds of other bones from various Australian localities which are preserved in this Museum. the interior being full of calc-spar crystals, or mineralized in such a manner as to remove all trace of organic substance. and render the bone quite brittle like a piece of stone. The modern fracture across the bone shows this extremely well. The ancient "crushed-in fractures" may possibly have been done with a stone tomahawk at the time when the bone was fresh. I have found the fractured crown of a *human molar* in the same matrix as *Diprotodon* and *Thylacoleo* at Wellington in this Colony. Man may therefore have been the contemporary of these animals and also of the *Dromornis*.

Since the discovery of this bone at Peak Downs, I have gone over the specimens in the Sydney Museum. and find more *Australian Moa-bones* in the collection. but unfortunately without date or locality, and of which therefore I can take no notice.

But on the 5th September, 1873. I received a letter from Mr. James F. Plunkett, informing me that he had forwarded me a parcel of bones, etc. They were from an alluvial gold-mining claim on the Black Lead, known as the Sand-hole. at a depth of 160 feet in a "pot-hole," imbedded in brown dust. The bones are of a whitish colour, and adhere strongly to the tongue. They consist chiefly of fragments of vertebræ, and probably belonged to a bird rather stronger built than our Emu (*Dromornis*), but not larger in size.

They are from Gulgang, one of our famous digging townships in the Bathurst district.

I may mention that Dr. George Bennett, F.L.S., has just received a very fine series of *Diprotodon* remains from his son Mr. George Bennett, from the Gamrie Creek, Darling Downs. I have examined them, and with the assistance of our eminent formatore, Mr. Henry Barnes, have succeeded in restoring the most important parts of this great animal.

The chief point established is the form of the jaw, the inflected angle of which resembles that of the Phalangers, and was not as deep as that of the Wombats. This part of the jaw has never been seen before, and will probably cause Prof. Owen to modify somewhat his restoration of *Diprotodon*. GERARD KREFFT.

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[1] The original specimen is now in the Sydney Museum.

[2] I had already described it in one of our local papers, and proposed for it the name of *Dinornis Queenii*.

AUSTRALIAN MUSEUM, SYDNEY, *Sep.* 28, 1873.

OBITUARY.

PROFESSOR AGASSIZ.

BY the death of Prof. Agassiz, Science has lost one of her most distinguished students. Louis Jean Rodolphe Agassiz was born on May 28th, 1807, in the parish of Mottier, between the lakes of Neuchâtel and Morat. He received his early education at Bienne, from which he went to the Academy at Lausanne, and afterwards studied medicine and science at the Universities of Zürich, Heidelberg, and Munich. In 1837 he was Professor of Natural History in the University of Neuchâtel, but long before this he had manifested that great power of investigation which speedily raised him to a high position among the scientific men of his time.

His earliest studies were directed to ichthyology, and especially to the fish of his native country. His first memoir on this subject was published in 1828, and in 1829 we find him describing the more remarkable fish obtained by Spix and Martius in their Brazilian travels. He afterwards turned his attention more particularly to fossil fish, for the classification of which he proposed a new system, founded on characters derived from the scales. In fossil ichthyology Agassiz speedily became the chief authority, and after publishing numerous memoirs treating of separate branches of this difficult subject, all of the highest value, he brought his labours in this department to their culmination by the publication of his magnificent "Recherches sur les Poissons fossiles," which appeared at Neuchâtel between the years 1833 and 1844 in five large quarto volumes, illustrated by the same number of volumes of beautifully prepared plates in folio. This work, which is admirably executed in all respects, is undoubtedly Agassiz's grandest contribution to scientific literature; it has never been, and probably never will be, surpassed. In aid of its publication the Geological Society voted the author the proceeds of the Wollaston Donation Fund in 1833, and in recognition of the valuable services rendered by him to this particular department of science, the same Society, in 1836, presented him with the Wollaston medal. Whilst this work was in progress, Agassiz engaged in the study of certain groups of fossils, especially those belonging to the class Echinodermata (starfishes and sea-urchins), upon which he published many memoirs, some of them prepared in conjunction with M. T. Desor. His "Nomenclator Zoologicus," commenced in 1842, but not completed until 1848, is a work of enormous labour, containing a nearly complete classified list of all names employed in zoology up to the date of its preparation for genera and groups of higher systematic value, *with references* to the authors who invented them *and the works in which they* were first used. A task of almost equal magnitude was the preparation of a "Bibliographia Zoologiæ et Geologiæ," intended to furnish a similarly classified catalogue of works published on these subjects. This list, originally prepared by Agassiz for his own reference, enlarged but very imperfectly edited, was published in England by the Ray Society between 1848 and 1854.

As if these labours, together with the duties of his professorship, were not sufficient occupation, Agassiz during this period also devoted much of his attention to the phenomena of glaciers and of glacial action, especially the nature of the movement of glaciers, and the traces of the former existence of such ice-rivers in places where nothing of the kind is now to be seen. He had, of course, fine opportunities of studying these phenomena in his native Alps, but he also visited this country and searched for traces of glacial action in the north of England, and in Scotland and Ireland. His researches and those of the late J. D. Forbes undoubtedly furnished the foundation for the views now generally received as to the nature and action of glaciers. We may safely say that the "Etudes sur les Glaciers," published by Agassiz in 1840, formed a most brilliant contribution to the literature of a subject until then involved in much obscurity, and that it gave him a European reputation in a line of research in which he was previously almost unknown.

In 1846 Agassiz was invited to go to the United States of America, and in 1847 he was appointed Professor of Zoology and Geology in the University of Cambridge, Massachusetts, where he remained until his death. In 1861 the Copley medal was awarded to him by the Royal Society, and he held honorary degrees from several universities.

His greatest literary work after his naturalization in America is his "Contributions to the Natural History of the United States," of which the reprinted "Essay on Classification" has had a great influence on zoology.

He published also in 1868 the results of the "Thayer Expedition," entitled "Journey in Brazil."

Among his smaller works we may mention his "Essay on the Study of Natural History," and his "Comparative Embryology," as of much value for educational purposes. In his general views Agassiz was strongly anti-Darwinian.

During his residence of twenty-seven years in the United States, Agassiz devoted himself heart and soul to his professorial duties, and mainly by his influence and popularity succeeded in attaching to the institution to which he belonged a most valuable museum of zoology and comparative anatomy, the results of the investigations carried on in which have already furnished many important memoirs. By his strenuous exertions he has raised in the United States a school of naturalists, many of whom, in the quality of the work done by them, quite equal their brethren on this side of the Atlantic, and from this point of view, at any rate, the States owe a heavy debt of gratitude to their great adopted citizen who has just departed.—*The Globe,* Dec. 16, 1873.

THE
GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE II. VOL. I.

No. II.—FEBRUARY, 1874.

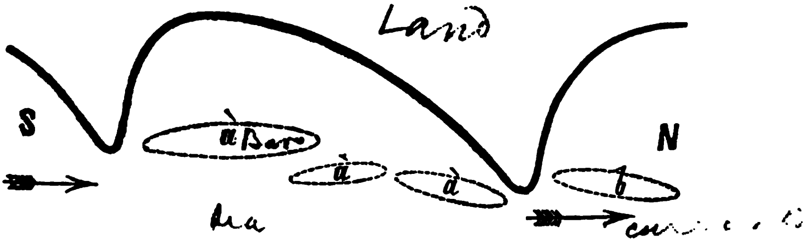
ORIGINAL ARTICLES.

I.—On the Origin of the Lagoon called The Fleet, Dorsetshire.

By G. H. Kinahan, M.R.I.A., etc., etc.

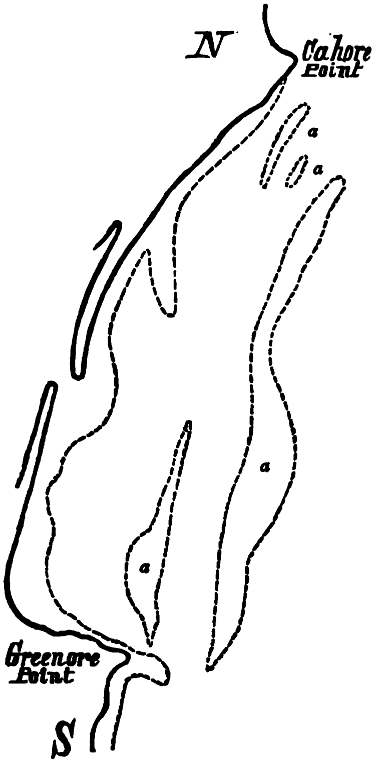
In the November Number of this Magazine (Vol. X. p. 481) the Rev. O. Fisher has called attention to the formation of the Fleet, Dorsetshire, and puts forward suggestions as to its formation in opposition to the sub-aerial denudation theory of Messrs. Bristow and Whitaker. To me the formations of the Fleet and Chesil Beach seem easily explained, as similar beaches are not uncommon on other parts of the English coast, and also on that of Ireland; but inland behind many of these banks the spaces that were formerly lagoons are now reclaimed land.

Tidal currents running parallel or nearly so to a coast-line, denude it evenly if all the rocks forming the coast-line are of similar hardness and resist its action equally. If, however, there are very soft or very hard portions, the former are denuded out to form guts or bays, while the latter are the nuclei of capes, points, and heads. When two headlands begin to form on, say, an east coast with the set of the incoming tide or principal current from south to north, at first there will be a long gradual curve formed between them, but eventually the current sweeping round the southern headland will denude the land rapidly on the N.E. of it, forming the south portion of the bay between the heads into an abrupt curve; while from the chart of the coast we learn that shoals (*a a a* and *b*) have accumulated *between the headlands*, due to the meeting of the



Diagrammatic Sketch of part of Wexford Coast.

currents of the water in the bay with the outside curr therefore, the land is raised a few feet, bars would be formed with their accompanying lagoons; and the latte quently would fill up or be otherwise modified by the we of the marginal cliffs and by matter carried into them drainage, the growth of peat, etc., till eventually the bo many would be raised so high that they could be drai reclaimed.

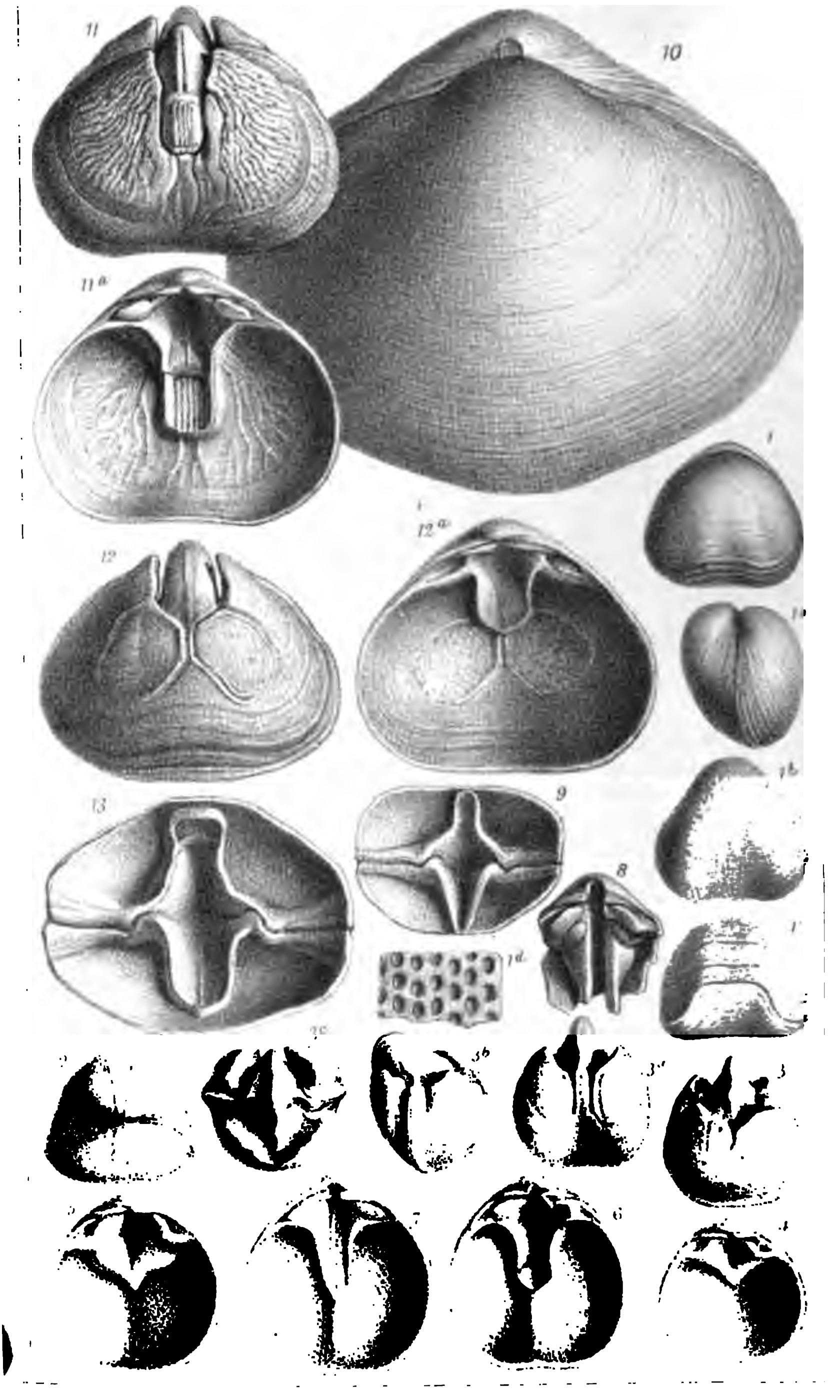


Sketch Map of the Bay and Shoals between Cahore and Greenore Points, Co. Wexford.

Thus have been fo the coast of Ireland the marshes, and reclaime situated N.W. of Wicklo the mudlands of Wexfo ary, N.W. of Greenor the lagoons called Lad and Tacumshin Lakes, Carnsore Point; the called Ballytiege Loug of Crossfarnoge Point; t and sands of Bann N.N.E. of Baginbun H lagoon called the Back Tramore, N.E. of Newto and many similarly lagoons and salt mar other portions of the Iri Therefore it seems prob the Fleet in Dorsetshir the marshes and low la are now reclaimed, fro land Island to Dover, a south coast of Englan formed similarly.

When the south coast land was a little lower present, there were sho ning obliquely from th of Portland; these w land rose became a b closing a lagoon; and as the lagoon exists, so must Chesil Bank, as the waters of t keep the bank from travelling inwards. Meteoric action, in forming the Fleet, probably filled it up more or less, as have formed slopes of the old marginal cliffs, while the strea have deposited matter in it, and peat-producing plants are g heightening the marshy shallows.

[See article "On the Formation of the Chesil Bank, Dorset," by Mess istow, F.R.S., and William Whitaker, B.A. (Lond.), Geol. Mag. 1869. 433, Pl. XIV. and XV., and p. 325, Noticed by Col. Geo. Greenwood, p. *the Authors at p. 574.* Referred to by Mr. Mansel-Pleydell in Geol. M *p. 445.—Edit.* Geol. Mag.]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10
11a
1
1a
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12a
1b
13
9
8
1d
1c
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2a
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II.—OBSERVATIONS ON THE GENUS *PORAMBONITES.*

By THOMAS DAVIDSON, F.R.S., F.G.S.

(PLATE III.)

IN 1830 Pander proposed the genus *Porambonites* for a remarkable group of Lower Silurian Brachiopoda, which abound in the neighbourhood of St. Petersburg, in Esthonia, and other parts of Russia; as well as in rocks of a similar geological age in Great Britain, Portugal, and other countries.

From the great difficulty of obtaining well-preserved internal casts, or interiors of the valves, much uncertainty has prevailed respecting its true characters, as well as with reference to the position the genus should occupy in the class. Some Palæontologists have referred it to *Terebratula*, others to *Spirifer*, *Orthis*, *Pentamerus*, *Isorhynchus*, and it has likewise been classed among the *Rhynchonellidæ* by D'Orbigny and others. After many years of patient search, and at different intervals, I have been able, through the kindness and liberality of Dr. Volborth and Prof. F. Schmidt, of St. Petersburg, to procure some good internal casts of three species, as well as several detached valves and fragments showing every portion of the interior of both valves in an admirable state of preservation. These I now propose to briefly describe and illustrate.

The external characters of the different species composing the genus have been correctly described and figured by several palæontologists, and therefore all we need mention is, that the individuals composing each species vary a good deal in form, and especially so at different periods of their growth, as may be seen by inspecting a series of examples of *P. æquirostris* from the dimensions of one line in length to that of nearly an inch. All the species are sub-circular, transversely oval, or sub-quadrate; the dorsal valve being the deepest or most convex, while there exists in the anterior half of the ventral valve a depression or sinus of greater or lesser depth. The beaks in both valves are so very much inflated and incurved, that they generally are nearly in contact, and leave scarcely any available space for the passage of the peduncular fibres of attachment.

In each valve, under the incurved beak, there exists a small narrow area and triangular fissure; the beak ridges are likewise sometimes very strongly defined. In a great number of specimens the extremity of both beaks, and especially that belonging to the ventral valve, present a circular hole. In some examples the aperture is so regular in shape as almost to lead one to conjecture that it may not have been entirely accidental, but it is more probable that these holes have been caused by friction, due to the opening and closing of the valves, the shell being very thin at that part. Externally all the known species are smooth, or rather ornamented by radiating rows of small pits, the shell structure, according to Dr. Carpenter, being impunctate.

The genus is composed of several well-defined species; the largest, *P. gigas (F. Schmidt), Pl. III. Fig. 10,* from Lychholm, in Esthonia, measuring two inches and a quarter in length, by three inches in breadth, and nearly two inches in depth.

The valves articulate by means of two strong teeth in the ventral valve, which fit into corresponding sockets in the dorsal one.

In the interior of the *ventral* valve much difference is not only observable in different species, but likewise so in specimens of the same species, as may be seen from Figures 6, 7, and 8. The general character would, however, consist in the presence of a long median flattened tongue-shaped space, slightly raised near its anterior angular extremity. This narrow longitudinal flattened space extends from under the incurved beak to a little in advance of half the length of the valve. The dental plates, which are very large, projecting, and thickened in some examples (Fig. 8), at first converge, and afterwards run close to, and parallel with, the sides of the median flattened space above described, and to within a short distance of its anterior extremity.

In other examples, such as in Fig. 6, the base of the inner sides of the dental plates, or septa, as they approach the middle, become so much thickened as to come into contact, leaving only a flattened lozenge-shaped area at the anterior portion of the tongue-shaped space.

Again, in some species, such as in *Porambonites* (*Pentamerus*) *ventricosa* (Kutorga), Fig. 11, the mesial flattened space is, comparatively, wide and divided at about half its length by a narrow horizontal slope. The position, and partly the shape of the dental plates or septa, is sometimes seen through the transparency of the shell, or upon specimens where the shell has been worn away (Fig. 2).[1]

In some species, such as in *P. æquirostris* (Figs. 6, 7), there exists a narrow raised ridge, which extends from the anterior extremity of the tongue-shaped mesial space to near the middle of the frontal margin, but this ridge is totally absent in other species, such as in *P. ventricosa*.

On the flattened surface of the anterior half of the mesial tongue-shaped space are situated the adductor muscular scars, flanked by the divaricator or cardinal impressions, and in this respect agreeing in position with what prevails in *Meristella* and several other genera among the Brachiopoda. The vascular impressions consist of two pair of primary vessels; one lateral pair partly surround the ovarian spaces, the other pair, after dividing the adductor from the divaricator muscular impressions, run to some distance towards the front margin of the shell, as is seen in Fig. 11*a*.

In the interior of the *dorsal* valve the converging socket ridges form two projecting sharp or much thickened plates or septa, shorter than in the ventral valve, and which sometimes show two dark lines on the surface of the cast (Fig. 2). These vary considerably in different species. In *P. ventricosa* (Fig. 12*a*) they are narrow, prominent, and inclose a rather wide oblong concave space, obtusely angular anteriorly. In *P. alta* (Pander), Fig. 9, these same plates are very much produced, and converge to an almost acute termination. Again, in *P. æquirostris* (Figs. 4 and 5), their base is very wide and thickened, and they converge laterally, so as to end anteriorly in an acute point. No cardinal projection, or process, is observable, and the muscular impressions seem to occupy (at least in part) the space inclosed by the socket plates. Two contiguous primary vessels (Fig. 12*a*) run at once direct from the centre of the valve, for some little distance, then divaricate, and finally become reflected, as seen in Fig. 12*a*.

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[1] At p. 112 of his "Monograph of the Permian Fossils of England," Prof. King alludes to these plates: "*Larger valve*, with two long more or less diverging dental *plates, and a median sinus. Small valve*, with two long more or less diverging socket *plates.*"

Such are the principal characters observable in the interior of both valves of this remarkable genus, and which I have been able to study in a great number of specimens. When looking into the interior of the rostral portion of both valves (as may be seen by taking a squeeze in gutta-percha from that portion of the internal cast), we see the hinge and the well-defined depressions or central chambers circumscribed by the dental and socket plates (Figs. 9 and 13). When these plates are much thickened at their base, they produce wide and deep indentures or depressions in the posterior portion of the internal cast, as may be noticed in Figures 3, 3*a*, *b*, *c*.[1] But when sharp and narrow, they leave deep slits in the same portion of the internal cast, as is seen in Figures 11 and 11*a*.

Porambonites therefore forms a small sub-family among the Brachiopoda, attached, at least during a part of its existence, by means of a pedicle, or its representative. No calcified process is observable for the attachment or support of the oral appendages, which were, no doubt, fleshy and spirally coiled. There are also in the interior of each valve diverging dental and socket plates, which laterally circumscribe the central muscular space.

Porambonites differs materially from *Pentamerus* and other genera by its internal arrangements, nor is there any apparent ground why it should be located in the family *Rhynchonellidæ*. The genus is confined to rocks of the Lower Silurian period.

EXPLANATION OF PLATE III.

Fig. 1, 1*a*, *b*, *c*.—*Porambonites æquirostris*, Pander. Lower Silurian. Pawlowish, near St. Petersburg.

Fig. 2.— ———— Specimen seen from the beaks, and showing the position of the septa.

Fig. 3, 3*a*, *b*, *c*.—*Porambonites æquirostris*, Pander. Internal cast. Poulkova, near St. Petersburg.

Fig. 4.— ———— Interior of dorsal valve taken in gutta-percha from the cast of Fig. 3.

Fig. 5.— ———— Interior of the dorsal valve from a testiferous specimen. Lower Silurian (1*a* of Schmidt's classification). Kuckers, Esthonia.

Fig. 6, 7, 8.— ———— Interior of ventral valve. Same locality.

Fig. 9.—*Porambonites alta*, Pander. Interior of rostral portion of both valves to

show the hinge and respective position of the dental and socket plates septa. Reval, Esthonia.

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[1] In pl. iii. figs. 28, 29, 30, of his Beiträge zur Geognosie des Russischen reiches, Pander gives a figure of *this same internal cast*, but which he erroneously considers to be a *Pentamerus*.

FIG. 10.—*Porambonites gigas*, F. Schmidt. Lower Silurian (2*a* of Schmidt's class cation). Lychholm, Esthonia.

FIG. 11.—*Porambonites* (*Pentamerus*) *ventricosa*, Kutorga. Internal cast of vent valve. 11*a*. Interior of same valve taken in gutta-percha from the sa cast. Lower Silurian. From quarries near the village of Paritzy, n Gatschina. This fine internal cast was found and presented to me by Pı Inostranzew.

FIG. 12.— ———— Dorsal valve from same internal cast. 12*a*. interior.

FIG. 13.— ———— Interior of the rostral portion of the valves, to show hi and respective position of dental and socket plates in each valve. Tal from the same internal cast.

III.—DESCRIPTIONS OF NEW FOSSILS FROM THE DEVONIAN FORMATION OF CANADA WEST.

By H. ALLEYNE NICHOLSON, M.D, D.Sc., F.R.S.E.;
Professor of Natural History in University College, Toronto.

(PLATE IV.)

(*Continued from page* 16.)

ALVEOLITES (CŒNITES ?) DISTANS, Nicholson.

Spec char.—Corallum ramose, the branches cylindrical, of diameter of from a line and a half to two lines, dividing dichot mously at intervals of about half an inch, t not anastomosing. Corallites oblique to t surface, with exceedingly thick walls. Cali extremely minute, about one-eighth of a line their longest diameter, sub-circular, transvers oval, or sub-triangular, level with the surfa and having the lower lip hardly or not at all pı minent. Intervals between the calices prop tionately very wide—usually about half a li

At first sight this species has very much t appearance of a *Cœnites* (such as *C. intertextu* or of the uncertain form *Alveolites* (?) *seria poroides*, Edw. and Haime. It is, howev distinguished from the former by the nc prominent and not markedly triangular calic and from the latter (which is almost certai not an *Alveolites*) by the fact that the coralli are disposed obliquely to the surface.

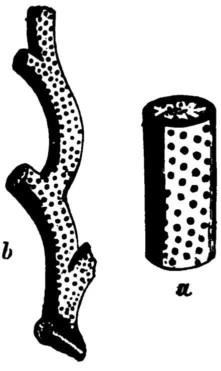


FIG. 4.—*Alveolites distans*, Nich. *a*. Fragment of the natural size. *b*. A portion of the same enlarged. From the Corniferous Limestone.

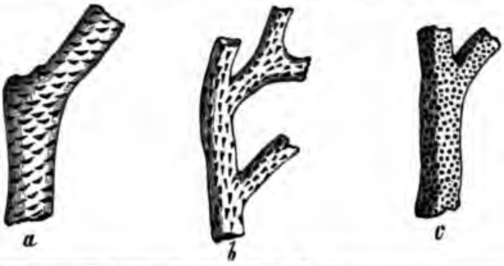
Alveolites distans is readily distinguished from the other ram species of the genus by the exceedingly small size of the calices a the proportionately great width between them, as well as by t fact that the calices are level with the general surface or nearly There is thus produced the fallacious appearance that the coralli are imbedded in an abundant cœnenchyma.

Locality and Formation.—Corniferous Limestone, Port Colborne

ALVEOLITES CONFERTA, Nicholson. Pl. IV. Fig. 5, *c*.

Spec. char.—Corallum ramose, composed of cylindrical or ell tical branching stems, which bifurcate, but do not interla *Diameter of the stems* from two to three lines. Corallites minu

5



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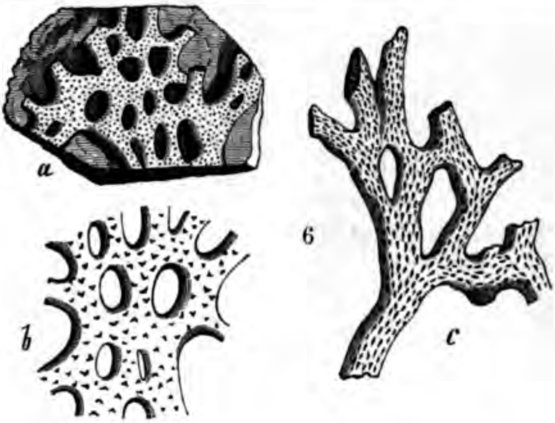

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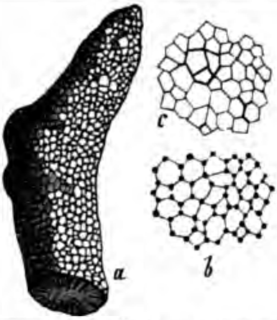

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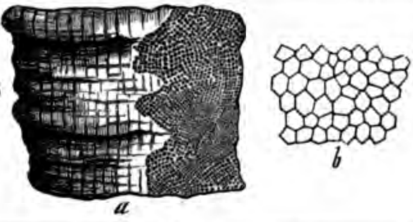

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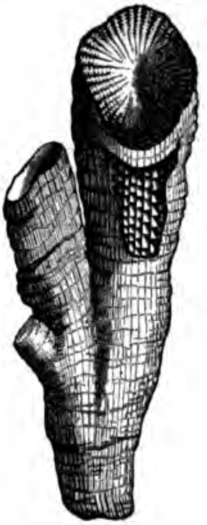


To illustrate Prof. H. A. Nicholson's **paper on New Devonian Fossils.**

e to the surface, opening by calices which are arranged in
lar diagonal lines, and which have a circular, or transversely-
ardly sub-triangular shape. Calices oblique and excessively
ed, about one-sixth to one-eighth of a line in their longest
er, and separated by intervals of from one-fifth to one-fourth of
transversely, or the same distance or less measured vertically.
are thus from three to four calices, and from two to three
aces in the space of one line, measured either diagonally across
ch or vertically.

olites conferta (Fig. 5, *c*) is allied to the forms described by
illings under the names of *A. labiosa* and *A. cryptodens*, and
lly to the former; but it appears to be decidedly distinct from
or from any other previously recorded forms. It is distin-
d by the very minute and close-set corallites, and by the fact
e calices are as a rule not distinctly sub-triangular, and have
arkedly prominent lower lip. No calicine teeth are present.
e respects *A. conferta* has the aspect of a *Cœnites*, especially
fact that the corallites at first sight appear to be surrounded by
or less copious cœnenchyma. This appearance, however, is
ive; and I have no doubt as to the correct reference of the
to *Alveolites*.

lity and Formation.—Rare in the Corniferous Limestone of
olborne and Ridgeway.

ALVEOLITES RAMULOSA, Nicholson. Pl. IV. Fig. 6, *a*, *b*.

. *char.*—Corallum reticulated, composed of flattened sub-
rical or cylindrical stems, from two-thirds of a line to two
diameter, commonly one line, branching with great frequency
terlacing to form a close network, the meshes of which vary
one to two lines in diameter. Corallites very minute, about
n the space of one line measured diagonally, about one-sixth
-eighth of a line in their longest diameter, separated by inter-
f rather more than one-third of a line. Calices apparently
ersely oval, or sub-triangular when perfect, but commonly dis-
triangular; lower lip sharp.

species represents in the genus *Alveolites* the anastomosing
ulata in the genus *Favosites*. It presents also a close resem-
in its external appearance to the *Cladopora reticulata* of Hall,
he Niagara group, from which, however, its structure sepa-
t widely. It is distinguished from *Alveolites labiosa*, Billings,
ich it is structurally most closely allied, not only by the re-
ed form of the corallum, but also by the much more minute
. It differs from *A. conferta*, Nich., again, in forming a net-
in the corallites being much more remotely placed, and in the
at the calices are generally distinctly sub-triangular or even
ular.

lity and Formation.—Not uncommon in the Corniferous Lime-
f Port Colborne and Lot 6, Con. 1, Wainfleet.

ALVEOLITES BILLINGSI, Nicholson.

. *char.*—Corallum reticulated, composed of cylindrical or sub-
rical *stems from two to three* lines in diameter, which branch

dichotomously for the most part at angles of about 40°, and anastomose to form an open network, the meshes of which are oval or diamond-shaped, and vary in length from three lines to three-quarters of an inch. As in the preceding species, the network is not always in a single plane, and the branches often coalesce at the nodes of the network to form flattened sub-palmate expansions. Corallites small, crowded, with thin walls, the calices sub-triangular, or, when worn, markedly triangular, with the apex of the triangle directed towards the base of the frond. About three calices in the space of one line, measured either diagonally or vertically. The long diameter of the calices is about one-fourth of a line or rather more, and the interspaces between them, measured diagonally, are about half as much. *Alveolites Billingsi* (See Fig. 6, *c*, which represents a fragment of the natural size, in which the surface is somewhat worn) is allied to *A. ramulosa*, but is distinguished by the larger size of the stems, the dichotomous mode of division, the more open network, and the larger size and closer arrangement of the corallites. From *A. labiosa*, Billings, it is distinguished by its reticulated form and more closely-set calices.

Locality and Formation.—Corniferous Limestone of Port Colborne and Lot 6, Con. 1, Wainfleet.

Genus CHAETETES, Fischer.

Gen. char.—Corallum ramose, massive, or incrusting, composed of elongated basaltiform corallites, which are in close contact and are not united by any cœnenchyma. Tabulæ well developed; septa absent; no mural pores.

The genus *Chaetetes* is nearly allied to *Favosites*, but is separated by the absence of mural pores. Very similar in all essential respects to *Chaetetes* is the genus *Stenopora* of Lonsdale, the differential character of which is stated to be the presence of minute styliform processes at the angles of the calices, whilst the corallites are contracted at intervals in planes parallel with the surface, and the ridges bounding the calices are granulated or tuberculated. Good authorities, however, reject the genus *Stenopora* altogether, and refer the forms placed here partly to *Favosites* and partly to *Chaetetes*. Lastly, the genus *Monticulipora* has been founded by D'Orbigny, to include species of *Chaetetes* which increase by gemmation, instead of fissiparously, as is ordinarily the case in the genus.

In the present state of our knowledge it seems almost impossible to separate these three genera; or, at any rate, it is certainly often impossible to decide positively, after the most careful examination and comparison, to which of them a given specimen may actually belong. In the Hamilton formation of Western Canada occur three small corals, which are certainly referable to one or other of these three genera, and which I shall provisionally consider as belonging to the genus *Chaetetes*. I have been unable to identify any of the three with previously described forms; and I have, therefore, been compelled, though with great reluctance, to consider them as new, though from the insufficiency of many existing descriptions it may subsequently be proved that they are some of them identical with forms already known.

CHAETETES MONILIFORMIS, Nicholson. Pl. IV. Fig. 7, *a*, *b*.

Spec. char.—Corallum ramose, the branches having a diameter of from three to five lines. Corallites polygonal, with thin walls, for the most part nearly equal in size, but having a few very small ones intercalated amongst the larger ones. The surface exhibits rounded eminences ("mamelons") placed at distances apart of rather more than a line, over which the calices are larger than in the intervals between them. About four of the ordinary calices occupy the space of one line. At each of the angles of each calice is a minute but conspicuous nodular thickening, which gives a peculiar beaded appearance to the surface, but which is not prolonged inwards into the interior of the corallite as a spine. On the contrary, well-preserved specimens show that these bead-like or moniliform thickenings of the angles of the calices are continued above the general surface in the form of short blunt spines, which communicate to the coral a roughness readily perceptible to the touch.

Chaetetes moniliformis appears to be readily distinguished from previously recorded examples of the genera *Chaetetes*, *Monticulipora*, and *Stenopora*, by the moniliform thickenings of the angles of the calices and the spiniform surface projections thence proceeding. The walls of the calices (Fig. 7, *b*) are thin, and are themselves destitute of spines or tubercles, the spines exclusively proceeding from the points where the angles of contiguous calices come together. *Stenopora spinigera* of Lonsdale carries spines, as its name implies, but these are borne by the walls of the calices all round, and the other characters of the fossil are different. *Stenopora exilis*, Dawson, from the Carboniferous rocks of Nova Scotia, also possesses spines; but these likewise spring from the margins of the calices, are much more numerous than in the present species, and are different in form and arrangement, whilst the calices are oval instead of being polygonal, and the entire coral is of a more slender and branching habit. In addition to its peculiar spines, *Chaetetes moniliformis* is further characterized by the comparatively large size of the calices, their thin walls, their polygonal form, and (with the exception of those occupying the "mamelons") their nearly equal dimensions.

Locality and Formation.—Rare in the Hamilton Shales of Widder, Township of Bosanquet.

CHAETETES BARRANDI, Nicholson. Pl. IV. Fig. 7, *c*.

Spec char.—Corallum ramose or forming small lobate masses, with a diameter of from two to five lines. Corallites polygonal, thin-walled, nearly equal, though with some smaller ones irregularly intercalated amongst the larger ones. The surface does not exhibit distinct eminences, but here and there are groups of corallites slightly larger than the ordinary ones, and separated by intervals of about a line and a half. From four to five calices in the space of one line.

This species (Fig. 7, *c*) is closely allied to *C. Goldfussi*, Edw. and H., but is distinguished by the fact that the calices are markedly polygonal, instead of being circular or oval, and that they are subequal, *with a very few smaller ones* intercalated amongst them, whereas in the latter species there are interspersed numerous exceed-ingly minute calices amongst those of ordinary size. From the wel known *Chaetetes tumidus*, of the Carboniferous rocks again, th present species is distinguished by the polygonal shape of the calice their thin walls, and their much larger size; the corallites of th former being thick-walled and nearly circular, and there being abou eight of them in the space of one line.

Locality and Formation.—Not rare in the Hamilton Group a Widder, Township of Bosanquet.

CHAETETES QUADRANGULARIS, Nicholson. Pl. IV. Fig. 8.

Spec. char.—Corallum forming exceedingly thin crusts of fro one-tenth to one-sixth of a line in thickness. Corallites sub-equal with very thin walls, about eight in the space of one line, for th most part polygonal, but often quadrangular in shape. The surfac is smooth, and destitute of eminences, nor are there groups of large corallites regularly interspersed amongst the smaller ones.

Chaetetes quadrangularis is found commonly encrusting *Heliophyllum Halli* and *Cystiphyllum vesiculosum*, and often forming expansions of considerable extent. The crusts, however, are of excessive thinness, and are apparently never composed of more than a single laye of corallites. It is distinguished from *C. tuberculatus*, Edw. and H to which it is most nearly allied, by the tenuity of the crusts, th smaller size of the corallites, the absence of distinct eminences o gibbosities of the surface ("mamelons"), and the very commonl quadrangular form of the calices.

Locality and Formation.—Not uncommon in the Hamilton shale of Bartlett's Mills, near Arkona, township of Bosanquet.

Genus HELIOPHYLLUM, Hall.

The genus *Heliophyllum* is particularly well represented in th Devonian rocks of Canada, no less than nine species having com under my notice as occurring in rocks of this age. Of these, si species, viz. *H. Halli*, *H. Canadense*, *H. Eriense*, *H. Hayugaense*, *H* *exiguum*, and *H. colligatum*, have been recorded and described b Mr. Billings (Canadian Journal, new series, vols. iv. and v.), an one species, viz. *H. Colbornense*, has been described by myself. Al these species occur in the Corniferous Limestone, *H. Halli* alone, s far as at present known, passing on into the Hamilton group. have now, however, to record from this last-mentioned formation on apparently new species of this genus, together with another from th Corniferous Limestone.

HELIOPHYLLUM SUB-CÆSPITOSUM, Nicholson. Pl. IV. Fig. 9.

Spec. char.—Corallum small, simple or compound, cylindrical, o slightly expanding towards the calice. Arched striæ upon the fla sides of the septa, and spines upon their free edges, placed at distance of from a third to a quarter of a line apart. Calice oval or circula shallow. Septa apparently sixty in number, at a diameter of eigh lines. Epitheca with numerous annulations and constrictions c growth. Occasional individuals, with the other characters of th , appear to be simple; but the majority of examples increas *production* of lateral buds. The new corallites thus pro duced by parietal gemmation are few in number (generally one or two, rarely three), and are directed upwards, nearly in the direction of the parent corallite. In some cases calicular gemmation appears also to occur.

H. sub-cæspitosum has a general resemblance to *Cyathophyllum cæspitosum*, Goldf.; but the presence of well-marked septal striæ and septal spines, proves it to be a true *Heliophyllum*. The latter species, also, is "fasciculated or astreiform," and increases principally by calicular gemmation, whereas *H. sub-cæspitosum* never produces sufficient buds to form aggregations of any size, and the increase is principally or entirely by parietal gemmation. It is, further, distinguished from the other forms of *Heliophyllum* by its comparatively small size, its cylindrical form, and its mode of growth, standing in this last-mentioned respect almost alone among the species of the genus. *H. proliferum*, Nich., increases in the same way, but is a much larger species, and is distinguished by other characters as well.

Young individuals of *H. sub-cæspitosum* are usually strongly nodulated with irregular growth-swellings, and have a length of from half an inch to an inch, with a diameter at the cup of from two to three lines. Large individuals have a length of from two to three inches, with a diameter at the calice of from eight to ten lines.

Locality and Formation.—Common in the Hamilton Shales of Bartlett's Mills, near Arkona Township of Bosanquet.

Heliophyllum proliferum, Nicholson.

Spec. char.—Corallum large, simple or compound; growing socially in particular localities, where numerous individuals occur together, nearly in contact, though not organically connected. Form cylindrical, with numerous irregular growth-swellings in the majority of examples. Calice moderately deep, with about sixty septa at a diameter of fourteen lines. The septa are unequally developed, and extend to the centre of the calice, where they are usually more or less twisted, and are sometimes elevated in the form of a central boss. Arched septal striæ and spines from a third of a line to half a line apart. Some individuals appear to be simple; but most increase by the production of lateral buds, which spring from the parent corallite in an obliquely ascending manner. The epitheca exhibits numerous encircling striæ and annulations of growth. Large individuals have a length of seven or eight inches or more, with a calicine diameter of an inch and a half, and a similar diameter throughout.

H. proliferum is readily distinguished from the other species of the genus by its elongated cylindrical form, its increase by lateral gemmation, and its social habit. Not only is the species composite, in the sense that most examples produce one or more lateral buds, but, so far as I have observed, it is strictly social, vast numbers of individuals occurring together, growing vertically, side by side, but separate. I have not seen more than one or two buds borne by a parent corallite, and calicular gemmation appears to be unknown. The *only other species of Heliophyllum* known to increase by lateral gemmation is *H. sub-cæspitosum;* but this is a very much smaller form, and is solitary in its habits. Detached individuals of *H. proliferum,* in which budding appears not to have taken place, may usually be recognized by their great length and almost cylindrical form, there being little or no increase of diameter as the calice is approached. There are also usually regularly developed constrictions and swellings of growth.

Locality and Formation.—Extraordinarily abundant in one bed of the Corniferous Limestone at Ridgeway.

EXPLANATION OF PLATE IV.

Fig. 5.—*a.* Fragment of *Alveolites cryptodens,* Billings. *b. Alveolites labiosa,* Billings. *c.* Portion of the stem of *Alveolites conferta,* Nicholson. All of the natural size. From the Corniferous Limestone.

Fig. 6.—*a.* Fragment of *Alveolites ramulosa,* Nich., natural size. *b.* Portion of the same magnified. *c.* Fragment of *Alveolites Billingsi,* Nich., natural size. From the Corniferous Limestone.

Fig. 7.—*a.* Fragment of *Chaetetes moniliformis,* Nich., enlarged. *b.* A portion of the surface of the same still further enlarged. *c.* A portion of the surface of *Chaetetes Barrandi,* Nich., greatly enlarged. From the Hamilton Group.

Fig. 8.—*a.* Portion of the crust of *Chaetetes quadrangularis,* Nich., encrusting *Heliophyllum Halli,* slightly enlarged. *b.* A few of the calices of the same greatly enlarged. From the Hamilton Group.

Fig. 9.—*Heliophyllum sub-cæspitosum,* Nich., of the natural size. From the Hamilton Group.

(*To be continued.*)

IV.—On the Formation of Mountains viewed in Connexion with the Secular Cooling of the Earth.

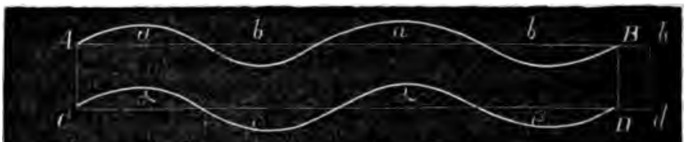
By the Rev. O. Fisher, M.A., F.G.S.

Being the substance of a paper read at Cambridge, December 1, 1873.

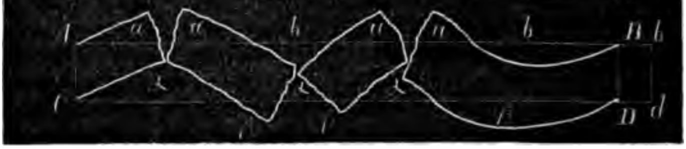
As a further contribution to the subject of mountain elevation, of which the Editor of the Magazine has given an interesting and lucid *résumé* in his late Presidential Address to the Geologists' Association,[1] I send an outline of a paper which was read by me in December before the Cambridge Philosophical Society.

The subject required to be treated in too technical a manner to appear in full in the Magazine, or I should have chosen that as the vehicle for its publication; for it was in truth a continuation of a paper which has already appeared in these pages.[2]

1.



2.



Referring to that paper for the explanation of the meaning of the symbols, and to the paragraph at p. 257, "If however," *et seq.*, for the proof of the equation, I have shown that

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[1] See Geol. Mag. 1873, Vol. X. p. 530.

[2] Vol. X. p. 248.

$$kle = \Sigma\,(a) - \Sigma\,(b).$$

I now extend the inquiry to any *area* of the surface of length l and width w, and the equation then becomes

$$2\,klwe = \Sigma\,(A) - \Sigma\,(B),$$

where $\Sigma\,(A)$ and $\Sigma\,(B)$ are the volumes of the elevations above, and of the depressions below, the "datum level."

The whole surface of the globe being next taken into account, the relation becomes,

$$\textit{Area of the Globe} \times 2\,ke = \Sigma\,(A) - \Sigma\,(B).$$

It is important to understand what is meant by the "datum level." It is an imaginary surface, which occupies the position which the surface of the crust would occupy at the present time, if it had been perfectly compressible, so that no corrugations would have been formed in it by lateral compression. For it would in that case have become simply more dense, without being disturbed in position.

The above relation assumes that the elevations and depressions, out of which the inequalities of the earth's surface have arisen, are due to lateral pressure, and that such pressure has acted everywhere parallel to the surface. Hence it is applicable to the earth's surface, although that is not strictly regular in its general form, and may contain local elevations and depressions affecting its mean figure,—that is, its mean figure as uninfluenced by lateral compression. For these inequalities, though of small amount as compared with the dimensions of the globe, may be large in comparison with the quantities of which we have to take cognizance in this investigation. Its truth in no way depends upon the arrangement of the disturbed rocks, nor upon the time at which successive movements have taken place, nor upon the alternate elevations and depressions which have at different times affected any given region. It includes every effect of subsequent denudation, from whatever cause, and to whatever amount. In short, it is perfectly general, so long as it is strictly interpreted. But it does not take account of elevations or depressions of regions of the surface arising from unequal contraction in a radial direction, if their result should be to cause a defect of parallelism between the datum level and the surface of the ocean, to which all our measurements must be in practice referred. However, it does not necessarily follow that contractions in the radial direction will cause depressions in the ocean bed accompanied with a corresponding increased depth of water. For instance, the defect from a true circular form in the equator affects the surface of the ocean, to which the measurements of geodesy are always referred, so that we do not get an additional mile depth of ocean at the extremity of the shorter radius.

Assuming then that the continents have been shaped out of the master elevations, and that the oceans indicate the positions of the master depressions, and that both are ultimately due to lateral pressure, I have estimated the value of $2ke$ for the whole globe *upon the following data:—*

(1) The area of the ocean is 146 millions of square miles.
(2) That of the land is 51 millions.
(3) The *mean* depth of the ocean is four miles.
(4) Its deepest parts are about five miles.
(5) The mean height of the land is 900 feet (as shown by Mr. Carrick Moore).[1]

From these data I have obtained as a probable value 2 *ke* = 11000 feet, which appears to me more likely to be too small than too large.

The meaning of this in plain language is, that if all the inequalities of the earth's surface were levelled down, they would form a coating 11,000 feet thick over the whole globe above the datum level; the datum level being such a surface as has been already defined.

Having thus obtained a value for the thickness of the coating which all the inequalities of the earth's surface would form, if levelled down, I was led to seek for a measure of the same thing on physical grounds. For this purpose I availed myself of Sir W. Thomson's paper "On the Secular Cooling of the Earth," as a basis to work from.[2] From Mr. R. Mallet's late investigations on the contraction of slag from an iron furnace,[3] I deduced a probable coefficient of contraction for melted rock, viz. 0·0000217 for 1° Far.; and with this I obtained a value for 2 *ke*, or the thickness of the coating above defined. Sir W. Thomson's investigation proceeds upon the supposition, founded upon Bischoff's experiments upon the contraction of melted rocks in cooling, that, if the earth, or an outer coating of it, were once in a molten state, then, as soon as a crust began to form, it would break up and sink, and thus the whole would be reduced to the temperature of incipient solidification before it could be permanently crusted over. From the time of such incipient solidification it has gone on cooling, subject to the laws of cooling of a solid.

He then proves that upon this supposition the temperature would increase from the surface downwards, at first at a nearly uniform rate, but at a greater depth much more slowly, until at a certain point such a temperature would be arrived at, as would be about sufficient to induce fusion under the pressure existing at that depth. Now the rate at which the temperature first begins to increase is known to be about 1° Far. for 51 feet. Sir W. Thomson has determined, by observation on the rocks at Edinburgh, that their conductivity on an average is 400. With these data he proves that if, for the sake of illustration, the temperature at which the crust began to solidify be taken at 7000° Far., then the time since such solidification commenced will have been about one hundred millions of years, and that at about 100 miles below the surface the melting temperature would be reached.

Proceeding upon these assumptions, with the coefficient of contraction for rock above mentioned, I have calculated the value of 2 *ke*, or the thickness of the coating which all the elevations would form if they were levelled down, and I find it to come out less than 800 feet.

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[1] Nature, 1872, vol. v. p. 479.

[2] *Edin. Trans. 1862;* and Natural Philosophy, p. 711.

[3] *al Soc. Trans. 1873.*

Still further, if instead of 7000° Far. we assume 4000° to be the temperature for melting rock, which seems to be justified by Mr. Mallet's experiments, then the value of $2ke$, or the thickness of the coating referred to, would be less than 150 feet. In the latter case the time since solidification commenced would be about thirty-three millions of years.

If we compare the values thus found upon two different suppositions respecting the temperature of melting rock (one of them being extravagantly large) with the value for the same measurement as determined by estimating the actually existing inequalities of the earth's surface, we cannot but be struck with the immense discrepancy between them, the latter being from 13 to 80 times as large as the former. I am consequently led to doubt the necessity for accepting Sir W. Thomson's restrictions upon the manner in which the earth has come into its present state, especially since it seems now generally admitted that Bischoff's results concerning the contraction of melted rock cannot be relied upon. This was pointed out in 1868 by Mr. David Forbes, and quite recently by Mr. Mallet, who has determined the contraction in passing from a molten to a solid state to be scarcely 6 *per cent.*, instead of 25 *per cent.*, as stated by Bischoff. Probably, therefore, when we take into account the intermediate condition of viscosity, we need not assume the breaking up and sinking of a crust formed over a molten globe. This view is supported by what Mr. Scrope tells us about a lava stream remaining liquid, and even more or less in motion in its central and lower portion for years.[1] Indeed, Sir W. Thomson is careful not to exclude as impossible "the case of a liquid globe gradually solidifying from without inwards, in consequence of heat conducted through the solid crust to a cold external medium."

If this has been what has happened, there may have been a much larger nucleus inclosed within the crust in early times than we have at present, and thus the corrugations formed would have been larger. And a great portion of that nucleus consisting of superheated rocks in a state of igneo-aqueous fusion, much of the water may have escaped in steam during the frequent volcanic outbursts of pristine ages, so that a large portion, at any rate, of the oceans now above the crust may have been originally confined beneath it; and thus a much greater amount of contraction may have taken place than mere cooling would account for.

It is obvious that this reasoning will apply equally well to the case of a solid globe originally covered with a sufficiently deep layer of molten rock, which is the condition supposed by Sir W. Thomson to be the most probable, a view strongly supported by Dr. Sterry Hunt.[2] and more in consonance with the rigidity considered requisite to obviate the production of internal tides. But at the same time it is to be remarked, that a highly fluid original condition of the interior may have lasted long after mountains commenced to be formed, and yet its condition need not continue such at the present time.

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[1] Volcanoes, *2nd ed. p. 84.*

[2] *American Journal of Science*, vol. v. p. 264.

V. On the Formation of Mountains; being a Reply to Captain Hutton's Article in the January Number, Page 22.

By Rev. O. Fisher, M.A., F.G.S.

THE cause of the formation of mountains is so difficult and so vast a question that I cannot undertake to answer all Captain Hutton's objections to what he concisely calls the "contraction" theory. Moreover, I feel that, as far as my endeavours can help to elucidate so great a subject, I shall do better to throw what I have further to say into a form which is not controversial. I desire not to be held a champion of any theory, and shall always honestly abandon any position, which subsequent consideration leads me to think untenable. Thus with respect to paragraph (7), p. 26, in Captain Hutton's rejoinder to my critique, I refer to the abstract I have sent to the Magazine of my paper lately read at Cambridge, for it supersedes some of the purely tentative suppositions to which Captain Hutton takes exception, and which I adopted six years ago as "not unreasonable," in order to test the application of the theory.

I have already admitted that some elevatory effect may probably be produced under the conditions that Captain Hutton supposes, as the consequence of "deposition," and I have shown what amount of elevation I should attribute to them on page 255, Geol. Mag. Vol. X.

I will now take in order Captain Hutton's replies to my criticisms under the headings as he has marked them.

(*a.*) (Par. 1). I refer the reader to my own statement of this argument; for I think Captain Hutton has not quite understood my meaning. I certainly did not intend to state that, on account of horizontal pressure, "no upward rising would take place," and do not see what words of mine can be thus paraphrased. But with this exception, my views are correctly stated in the first paragraph.

(Par. 2). The damped paper stretched on a board is an excellent illustration, and, I may remark, does not usually rise up into a dome. But it needs to be observed that exactly the same effect of wrinkling would result from a contraction of the board as from the expansion of the paper. Mr. Maw's example is also in point, so long as the tracts of the earth's surface, which we compare to the brick coping, are not too large in comparison to their thickness, and of sufficient homogeneity and rigidity to be fairly represented by a course of bricks laid edgeways.

(Par. 3). In the fundamental proposition of my paper "On the Elevation of Mountains," 1869, I am seeking the utmost pressure which could accrue, if the shell were self-supporting and did not give way. For *this purpose* I suppose it rigid; but by no means say it is so, but the contrary. If it were rigid, we should get a certain enormous pressure. Since it is not rigid, it gives way; and the maximum pressure is never attained. I have been entirely misunderstood here.

I cannot quite make out whether Captain Hutton means to express [illegible]e same thing that I understand by "an arch" or "dome." If by [illegible] arch or dome he means what usually go by those names, then the [illegible] *is not analogous* to that of a portion of the earth's spherica crust. Because in the case of an arch or dome part of the force of gravity may be resolved in the direction of the curve of the arch or dome everywhere, except at the crown; and the conditions of equilibrium depend essentially upon this fact. In the case of the earth's crust, considered as a whole, such is not the case, for gravity is everywhere perpendicular to the surface. Any small portion of the crust, however, which has been already elevated (by any means) into an anticlinal, is to some extent under the conditions of an arch or dome, and may be partially supported as an arch or dome would be, as I have particularly pointed out in my paper of 1869.

The gist of my argument against Captain Hutton's main proposition lies here. For if the portion of the crust supposed ready to expand beneath newly-deposited matter were maintained, partly by forces acting as the pressures act along an arch,—*that is, partly upwards* or against gravity,—then, if the crust expands, an upward movement will ensue; and this seems to be Captain Hutton's view. But if, as I contend, the forces along the crust are *horizontal*,—that is, at right angles to gravity,—expansion will not cause any direct *upward* pressure; and there will be, consequently, no tendency to raise the portion of crust into a dome in preference to crumpling it into any other form, which would equally suffice to relieve the pressure; and in which, by a due admixture of synclinals with anticlinals, the centre of gravity of the portion as a whole would be raised only by the small amount necessarily due to its deformation.

(*b.*) I by no means consider that such crushing as I contemplate is inconsistent with the formation of anticlinals. On the other hand, I have expressly stated that horizontal pressure would break up a layer of rock into "a series of synclinals and anticlinals interspersed with faults." (By-the-bye, we hear little about synclinals in Captain Hutton's theory.) Before we can argue upon the word "crushing," we must define what it means when applied to matter operated on upon so grand a scale as the earth's crust has been. There are but few (I will not say no) mountain sections in which I should not call the strata "crushed."

On the "contraction" theory, the *upper* strata of aqueous rocks will have been subject to *less* compression, because they have experienced the effects of only the later stages of contraction. They are not therefore subject, as Captain Hutton says, to the greatest, but to the least compression. The difference of compression resulting from the curvature of the surface in the upper and lower parts of the crust would be absolutely inappreciable, on account of the small thickness of that crust, compared to the dimensions of the globe.

(*c.*) I think my reasonings referred to under this head are correct upon the premisses. I did not make the sinking of an adjoining area one of these. But the possibility of such an occurrence, and its effect, is taken account of in other parts of my paper.

(*d.*) In what I am told is my fourth argument, I do not recognize myself at all. It is said to be that the specific gravity of the disturbed rocks "*ought*" *to be less than* it was before. "This would *be the case with the rocks that* caused the movement only while they were heated, and even then the difference would be too small to detect." This reads as if I grounded an argument upon experiments upon the specific gravities of the rocks! In considering the conditions of equilibrium of the expanded rocks, it is perfectly true that I have assumed their specific gravity to be altered in the inverse ratio of the volumes, which I suppose no one will deny to be correct in principle.

I will not follow Captain Hutton into his "reasons for rejecting the contraction theory" at present; but if, as I hope to do, I pursue the subject further, I will bear them in mind, and I think I shall be able to meet many of them. I trust in the meanwhile that he will not be too absolute in his rejection; for it is certain that the earth is a cooling sphere, and consequently must be a contracting one. And if it be a contracting one, the superficial rocks must have been deranged by compression. And when we look at sections, whether in the field, or in diagrams to true scale, we cannot but be astonished at the *amount* of this compression, which must somehow or another be accounted for; and the "deposition" theory may claim attention as one partial mode of doing this. Nor need we be very much alarmed by such considerations as are advanced under Captain Hutton's eighth head. For a rate of shrinking in the earth's radius of 2½ feet in a century, which is about 17 yards in 2000 years, would diminish the length of the day during *six* thousand years by only 3–5ths of a second of time.[1]

I should much like to see a diagram showing a range of mountains formed on Captain Hutton's theory. I dare not attempt to offer one myself, for it would either be too unlike any ordinary mountain section, or else I should lay myself open to the rejoinder that I have entirely misunderstood the question. I say this because I think that continuous domes, such as Captain Hutton relies upon for the elevations given in his table, are quite exceptional phenomena, if indeed they are to be met with. But my chief objection to his particular theory is, that I cannot see how, on mechanical grounds, the compression which would accrue from the expansion which he supposes would raise a dome at all.

Finally, I cannot refrain from saying that I believe, in the past history of the earth, there are probably causes to be taken into account, which have not as yet been dreamt of. And there are facts to be accounted for, which as yet are wholly beyond the reach of our theories. Though every step of reliable knowledge is an advance in the right direction, yet it is highly probable that the goal will never be fully reached by man's finite powers.

[Errata in Rev. O. Fisher's paper on the Formation of Mountains, Vol. X. No. 6, p. 258, line 14 from top, for $l\ (1 + e) \times 1$. read $l \times 1$. Page 260, note 3 should stand—See a paper on Coral Reefs by J. C. Ward, in the "Popular Science Review" for April, 1873, p. 170.]

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[1] Pratt's Figure of the Earth, 4th edition, p. 204.

VI.—On a New Section of Pre-Glacial White Clay and Sand near Mold.

By D. Mackintosh, F.G.S.

Mr. GEORGE MAW, in the Geological Magazine, Vol. IV. pp. 24 and 299, has described a number of sections in Flintshire and Denbighshire in which white clay or sand occurs under Boulder-clay. A newly-exposed section near Colomendey Hall, about three miles from Mold, is very important on account of the complete series of glacial drifts by which the white clay is overlain. I lately examined it in company with Mr. Manning, of the Chester Natural Science Society.

Section of Deposits near Colomendey Hall.

(order descending).

Brown clay, with a few nearly angular stones, some of them scratched; 7 feet in thickness.

Sandy and clayey gravel, with numerous stones (both small and rather large), most of them rounded, and some of them scratched; from 2 to 3 feet.

Brown clay, with many stones, and at its base large boulders, most of them much scratched and striated; about 6 feet.

Bluish or dark-coloured clay, with many stones, the latter much polished, and intensely and often uniformly scratched and striated; greatest thickness about 6 feet.[1]

The stony blue clay graduating downwards into laminated stoneless blue clay, with black carbonaceous matter; about 3 feet.

The above passing downwards into more or less laminated white clay graduating into white sand; about 18 feet.

7. Broken and decomposing chert.
8. Carboniferous Limestone rock.

Remarks.—The basin in which the above deposits are packed is said to be about 300 yards in diameter. The broken chert, white sand, and clay would appear to have been accumulated before the glacial period. Before or at the commencement of the deposition of the blue clay there would seem to have been a sweeping of carbonaceous matter into the hollow, and a washing up, staining, and partial re-deposition of the upper part of the white clay. Severe glacial conditions must have accompanied the accumulation of the blue clay; and during the continuance of these conditions, a more or less different source of supply must have furnished the materials composing the lower brown clay. The gravel-bed and the clay above would appear to have been deposited during very mitigated glacial conditions. The white clay, according to Mr. George Maw, may be regarded as the residue of the limestone, after the calcareous matter was carried away by aqueous dissolution. If so, the silica and alumina composing the white clay, however short a distance it may possibly have travelled in this instance, must in one case at least have been carried a considerable distance from the parent limestone rock. In the Mold valley, three miles off (as lately ascertained by boring operations), the order of the drifts and white clay is much the same as at Colomendey, though the underlying rock belongs to the Coal-measures. There is some reason to believe that in this area one or more lakes existed in preglacial times.

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[1] Nearly all that can be seen of the blue clay fills up a hollow in the white clay. But a bore-hole *at some distance from the pit* reveals its existence in the same *position relatively to the other deposits.*

The boulders in the drifts at Colomendey are chiefly limestone, though felstone is likewise present. Many of the smaller stones consist of vein quartz and Wenlock shale or grit. The fact that many of the stones must have come from some distance, and a few of them (the felstones) from a great distance, is sufficient to show that the drifts could not have been deposited by a cause limited to this particular hollow, and that here they must either have been arrested, while in exposed situations no deposition took place, or that a more extensive deposition was followed by denudation, which left this patch on account of its being protected. The preglacial white clay is probably a freshwater deposit. The overlying drifts must have been accumulated by the sea, floating ice, land ice, or by those three agencies combined. It is worthy of remark that many of the small stones in the blue clay are much rounded, as if they had been subjected to attrition under water. This clay evidently belongs to the oldest drift yet discovered in the north-west of England and Wales. On washing it, its structure is found to differ from that of the lower brown clay of the plains, and likewise from that of the pinnel of the Lake District. With a hummocky and much denuded surface, a similar blue clay is found underlying these deposits on the coast of North Wales and in Cumberland.[1]

NOTICES OF MEMOIRS.

I.—The Secondary Rocks of Scotland. (Second Paper.) On the Ancient Volcanos of the Highlands, and their Relations to the Mesozoic Strata.[2]

By John W. Judd, F.G.S.

Introduction.—The vestiges of the Secondary strata on the wes coast of Scotland have been preserved, like the interesting relic of Pompeii, by being buried under the products of volcanic eruptions. The deposition of the Mesozoic strata in this district wa both preceded and followed by exhibitions of volcanic phenomen on the grandest scale; and it is only by a careful study of th records of these two great periods of igneous activity that we ca hope to understand the remarkable relations of the fragments of th intermediate sedimentary formations, or to account for the peculiarities which they present.

That the rocks forming the great plateaux of the Hebrides an the north of Ireland are really the vestiges of innumerable lav streams, is a fact which has long been recognized by geologist That these lavas were of *subaerial* and not *subaqueous* origin, i proved by the absence of all contemporaneous interbedded sed mentary rocks, by the evidently terrestrial origin of the surfaces o which they lie, and by the intercalation among them of old soil ts, mud-streams, river-gravels, lake-deposits, and masses of tified tuffs and ashes. From the analogy of existing volcanic ts, we can scarcely doubt that these great accumulations of s products, which must originally have covered many nds of square miles, and which still often exhibit a thickness 0 feet, were ejected from great volcanic mountains; and a study of the district fully confirms this conclusion, enabling eed, to determine the sites of these old volcanos, to estimate imensions, to investigate their internal structure, and to trace tory of their formation.

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[1] See Geol. Mag. Vol. VII. Oct. and Dec. 1870, and Vol. IX. January, 1872.

[2] *Abstract of a paper* communicated to the Geological Society on January 21, 187

Tertiary Volcanos.—The petrology of the Western Isles has ade the subject of careful study by Professor Zirkel, of g, to whose investigations we are very deeply indebted. The y igneous rocks may be classified, according to their ultimate al composition, into two series, known as the acid and basic s rocks. In each of these series the proportions of the ingredients in its various members are almost identical; but cture the rocks of either series vary from the coarsest crystal-ggregates to the most perfect glass. The acid series consists nite, felsite, felstone, and pitchstone; the basic of gabbro, e, basalt, and tachylite; the members of either series exhibit erable varieties, and pass into one another by the most in- e gradations. The igneous rocks of both classes form *lava-* s, often of great thickness and extent, and exhibiting many ting peculiarities of the amygdaloidal and columnar structures; *e masses* varying in size from great mountain groups to the st dykes and veins; *volcanic agglomerates*, composed of the and ashes ejected from volcanic vents; and *volcanic breccias* p in great part of the fragments of the various Palæozoic and ary rocks through which the volcanos have burst. Among canic agglomerates are found beautiful examples of the more of the species of minerals characteristic of the neighbourhood anic vents.

relations of these several igneous products to one another are ully exemplified in the Island of Mull. We here find proof e volcanic activity of the Tertiary period commenced with ption of felspathic lavas and associated fragmentary materials. were accompanied by the intrusion among the surrounding which they greatly metamorphosed, of great masses of fluid acid composition, and the extrusion among the other igneous ts of similar liquefied materials, which consolidated into and granite. The great volcanic mountains thus formed to have remained in a state of comparative quiescence for a riod, during which they were subjected to great denudation, en through their midst were forced great masses of fluid rocks, which continued to flow at intervals during enormous , and gave rise to streams of basalt which accumulated to the ss of many hundreds and even thousands of feet. The great ve bodies of this same rock consolidated into mountain masses *ro and dolerite.* While the earlier felspathic lavas appear to have rarely flowed to a distance of more than ten miles from the volcanic vent, those of basaltic character often extended to distances of fifty or sixty miles, or even more. The same difference of behaviour of the two classes of lava has often been remarked in the case of existing volcanos.

Besides the volcano of Mull, we have evidence of the existence of four other great vents in the northern part of the Hebrides, namely, in the peninsula of Ardnamurchan, and in the islands of Rum, Skye, and St. Kilda respectively. In each of these a period characterized by the eruption of felspathic lavas was followed, after a considerable interval, by one during which nearly all the materials thrown out were of basaltic composition. The volcano of Mull is in a far more perfect state of preservation than the others, owing to the great amount of central subsidence which has taken place in its mass. This central subsidence appears to be strictly analogous to that which has been shown by Mr. Darwin, Mr. Heaphy, and Krug von Nidda, to have occurred in the case of recent volcanos in the Cape de Verde Islands, New Zealand, and Iceland. From an examination of the areas covered by the great Tertiary volcanos of the Hebrides, and of the interesting data afforded by the present positions of their lava-streams, etc., we are able to estimate that while the volcanos of Mull and Syke were certainly of far greater bulk than Etna, those of Ardnamurchan, Rum, and St. Kilda could have been of scarcely inferior dimensions.

There is proof that after the extinction of the five great volcanos of the Northern Hebrides and the very extensive denudation of the great plateaux composed of their lavas, there burst out a number of sporadic eruptions which resulted in the formation of comparatively small volcanic cones, analogous to the "puys" of Central France, which have been so admirably described by Mr. Poulett-Scrope. These "puys" of the Hebrides are very numerous, and are exhibited to us in various stages of preservation.

The formation of the various volcanic piles of the Western Isles was accompanied by the intrusion of innumerable igneous masses of all sizes among the surrounding older strata. The liquefied rocks of acid composition accumulated in great lenticular masses in the midst of the stratified rocks, consolidating into felsite and granite; while the heavier and more fusible basaltic materials spread between the strata in vast sheets of enormous extent, which, when cooled, formed dolerite and basalt. Besides the larger intrusive masses, the whole district around each of the volcanic vents is traversed by a wonderful plexus of dykes and veins, composed of both acid and basic rocks, some of the dykes of basic composition extending to extraordinary distances, as pointed out by Prof. Geikie. The great igneous masses, besides *disturbing* the older strata through which they have been forced, have effected a remarkable *metamorphism* in them, the amount of this metamorphism and the distance to which it extends being in each case proportioned to the bulk of the intrusive mass.

From a consideration of the whole of the evidence it appears highly probable that the first period of igneous activity (namely, that of the eruption of felspathic lavas from the great volcanos) was contemporaneous with the Eocene sedimentary formations; the econd period, that of the great and prolonged outbursts of basaltic vas from the same vents, was certainly that of the Miocene; while e third period, or that of the formation of the "puys," may, with a eat show of probability, be correlated with the Pliocene.

The igneous activity during the Tertiary period in the Northern ebrides appears to have extended in all its magnitude, and to have hibited similar stages in its development, far to the southwards, s illustrated by the rocks of Arran, Antrim, and the Mourne untains. But even this tract, extending 400 miles from north to uth, which was characterized by grand volcanic phenomena during whole of the Tertiary period, can only be regarded as a portion the great belt of volcanos which at that epoch extended through eenland, Iceland, the Faroe Islands, the Hebrides, Ireland, Central ance, the Iberian peninsula, the Azores, Madeira, Canaries, Cape Verde Islands, Ascension, St. Helena, and Tristan d'Acunha, and ich constituted, as shown by the recent soundings of H.M.S. hallenger,' a mountain-range comparable in its extent, elevation, d volcanic character with the Andes of South America. The mirable manner in which the relations between the Volcanic and utonic rocks are exhibited in the old volcanos of the Hebrides, nders them of special interest to the geologist; and the further ustrations of the same phenomena which are afforded to us by the ics of a still older series of volcanos, are made more clear and iking by the aid of their analogies.

The Newer Palæozoic Volcanos.—In the district of Lorn we find great series of old felspathic lavas which, in their lower part, ernate with conglomerates and sandstones, and which, in their gher portions at least, appear to be of subaerial origin. It is ident that we have here the relics of what was once a widely reading plateau, made up of lava-streams, like that of Tertiary age eady described. These rocks were evidently formed long subsequently to the Lower Silurian strata, but before any of the Secondary diments were deposited.

The central and southern districts of Scotland exhibit enormous sses of igneous rocks, in part at least of subaqueous origin. These hibit a very close similarity in petrological character with the lavas Lorn, and are shown, by the interbedded and contemporaneous siliferous sediments associated with them, to range in age from e Lower Old Red Sandstone to the Lower Carboniferous.

Along the whole line of the Grampian Mountains we find a number granitic masses connected with a wonderfully complicated series veins and dykes of rocks of similar composition. These igneous trusions, which disturb and metamorphose the surrounding strata, e evidently, as shown by Murchison and Geikie, of far later date an the Lower Silurian, but are earlier than the Secondary strata.

Concluding, as we cannot avoid doing, that these igneous intruons and the *subaerial and subaqueous* lavas of similar composition were all formed during the Newer Palæozoic periods, we are led to the presumption of their probable former connexion with one another. By the phenomena presented at a number of interesting points, such as Beinn Nevis and Glencoe, where the granite rocks and the lavas are so associated with one another and with masses of volcanic agglomerate as to demonstrate the identity of their origin with that of the similar masses of Tertiary age in the Hebrides, this presumption is converted into certainty. The Newer Palæozoic period of volcanic eruption terminated, like that of the Tertiary epoch, by a grand development of "puys" during the Carboniferous and Permian periods. Of these, the celebrated Arthur's Seat, near Edinburgh, and many similar cases in Fife and the Lothians, may be cited as examples.

Conclusion.—It appears that during the Newer Palæozoic and the Tertiary periods, the north-western parts of the British archipelago were the scene of displays of volcanic activity upon the grandest scale. During either of these, the eruption of felspathic lavas, etc., preceded, as a whole, that of the basaltic; and in both, the volcanic action was brought to a close by the formation of "puys." The range of Newer-Palæozoic volcanos arose along a line striking N.E. and S.W.; that of the Tertiary volcanos along one striking from N. to S.; and each appears to have been connected with a great system of subterranean disturbance. It is an interesting circumstance that the epochs of maximum volcanic activity, the Old Red Sandstone and the Miocene, appear to have been coincident with those which, as shown by Prof. Ramsay, were characterized by the greatest extent of continental land in the area.

The Secondary strata were deposited in the interval between the two epochs of volcanic activity, and the features which they present have been largely influenced by this circumstance. Apart from this consideration, however, the volcanic rocks of the Highlands are of the highest interest to the geologist, both from their enabling him to decipher to so great an extent the "geological records" of the district, and from the light which they throw upon some of the obscurest problems of Physical Geology.

II.—BRIEF ABSTRACTS FOR 1873.

THE following Abstracts are intended to serve as the commencement of a "Record of Geological and Palæontological Literature for 1873," to embrace abstracts of all papers published abroad or in the provinces.[1]

ANON. Geological List. 1873. *2nd Rep. Winchester Coll. Nat. Hist. Soc.*, pp. 80–82.

A list of the principal sections in the neighbourhood of Winchester, with a note of the fossils that have been found in them, followed by a short "Synopsis of the Fossil Fauna."

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[1] The work will be carried on under the direction of a Committee appointed by the British Association, which at present consists of Mr. Henry Woodward, Prof. Williamson, Mr. F. W. Rudler, Mr. L. C. Miall, Mr. W. Topley, Mr. W. Whitaker, Mr. G. A. Lebour, Mr. W. Carruthers, and Mr. Horace B. Woodward. The co-operation of geologists is earnestly desired. Copies of papers and Transactions of Local Societies will be gladly received by the Secretary to the Committee, Henry Woodward, EDIT. GEOL. MAG.

Hutchinson, P. O. Submerged Forest and Mammoth Teeth at Sidmouth. *Trans. Devon. Assoc.*, vol. vi. part i. pp. 232-235.

In the winter of 1872 reefs of rocks and beds of clay that had not been seen for many years were laid bare on the coast at Sidmouth. In the alternations of clay and gravel shown there were stumps of trees, which must have grown in their present positions when the land was at a higher level than now, as they are about eight feet below high-water.

Linford, W. On Quarries at Beer, in Devonshire, and some of their Fossils. *Trans. Edin. Geol. Soc.*, vol. ii. part ii. pp. 181–184 (and p. 190).

Of these quarries, three are subterranean and one open. The section of the last is given as follows:—Layers of chalk, layers of sandstone, layers of freestone, and a coarse sandstone, which probably rests on greensand. All the beds belong to the Chalk, and are mostly fossiliferous. In the upper part of the Chalk with flints, a few pebbles and one small boulder have been found. The freestone is much used for building.

Parfitt, E. Annelids *versus* Raindrops. *Trans. Devon. Assoc.*, vol. vi. part i. pp. 107–110.

This is a rejoinder to a paper by Mr. T. M. Hall, wherein certain markings on some North Devon rocks were referred to the action of rain, or rather of drifting sand, during their deposition. The author argues that these markings are those of worms, from the facts that the impressions are in different directions, whilst if they had been caused by a shower they would have been in one direction; and that they occur in the rocks to a vertical depth of at least thirty feet, which, on the raindrop theory, would need a storm lasting for very many years.

Pengelly, W. (1) The Ossiferous Caverns and Fissures in the Neighbourhood of Chudleigh, Devonshire. (2) The Literature of the Cavern at Ansty's Cove, near Torquay, Devonshire. (3) The Literature of the Caverns at Buckfastleigh, Devonshire. *Trans. Devon. Assoc.*, vol. vi. part i. pp. 46–72.

These papers, the continuation of a series on Devonshire Caverns, give a full account of what has been written on those in question, with explanatory remarks by the author. The first two caverns are ossiferous, but those at Buckfastleigh are not.

Pengelly, W. The Granite Boulder on the Shore of Barnstaple Bay, North Devon. *Trans. Devon. Assoc.*, vol. vi. part i. pp. 211–222.

The author first notices what has been written on this boulder (a block that weighs over ten tons), and then considers the questions that it suggests. (1) As to its origin, which he concludes may be from the west of England, or may be from the north. (2) As to its transportation, which it is argued must have been brought about by ice-action. *(3) As to its age, which* must be far removed from our own time, for the boulder underlies the raised beach of Barnstaple Bay. And as that beach contains shells of the same species as those now living on the coast, which are not dwarfed (as they would have been in an icy sea), it is inferred that the boulder must have been deposited long before the beach above it.

W. W.

PROCEEDINGS OF THE LITERARY AND PHILOSOPHICAL SOCIETY, MANCHESTER.

BINNEY, E. W., F.R.S. (Jan. 21st, 1873), exhibited drawings o petioles of specimens allied to *Anachoropteris Decaisnii* of Renault of oval form, from the Lower Coal-measures of the Foot Mine, nea Oldham, Lancashire. Also a plant from the Lower Brooksbotto seam of coal, allied to the genus *Anachopteris*.

PLANT, JOHN, F.G.S. (Jan. 27th, p. 113.) "Description Minerals and Ores from Venezuela," Collected by Mr. J. M. Spenc Gold quartz, galena, copper ores, iron ores, coal, and graphite.

WILLIAMSON, Prof. W. C. (Feb. 4th), stated that the second pla described above was not a new genus, but the fruit of *Asterophyllite*

BROCKBANK, William, F.G.S. (Feb. 18th). "Notes on suppose Glacial Action in the Deposition of Hæmatite Iron Ores in the Fu ness District." Hæmatite occurs (1) filling hollows in limeston capped by glacial drift; and (2) in veins in the limestone, and i irregular pockets. The author considers the iron ore to have bee transferred by the action of an ice-sheet from the place of its origin occurrence, and redeposited with the glacial drift in the crevices an hollows of the limestone (1). Giving a section at Dalton-in-Furne to explain his views.

DAWKINS, W. Boyd, F.R.S. "The Results of the Settle Ca Exploration." (p. 61.) Romano-Celtic enamelled jewelry an implements, in the upper bed of the Victoria Cave, of the era pr ceding the conquest of West Yorkshire and Mid-Lancashire by t Northumbrians. Beneath this stratum lay six feet of angular ston with neolithic flint flakes. Below occurred a stiff clay, believed be of glacial origin, nearly thirty feet thick, resting on an ossifero bed, with remains of cave bear, mammoth, reindeer, etc.

BINNEY, E. W. (March 4th, p. 72), states that the plant believ by himself to belong to a new genus, alluded to by Prof. Williamso as belonging to the genus *Asterophyllites*, was described by Pro Renault, of Cluny, as a *Sphenophyllum* (*Comptes Rendus* for 1870).

DAWKINS, W. Boyd, F.R.S. (March 18th, p. 83.) "Observ tions on the rate at which Stalagmite is being accumulated in t Ingleborough Cave." Three holes were bored, and gauges of bra wire gilt inserted in the base of the stalagmite, 13th March, 187 The possible age of the "jockey cap" stalagmite was calculated i 1845 by Prof. Phillips, from observations of Mr. James Farrar, at 25 years. Mr. Dawkins found the rate of increase to be 0·2946 inch year, and that the whole of the stalagmite and stalactites of t Ingleborough Caves may not date further back than the time *Edward the Third.*

BROCKBANK, William, F.G.S. "Notes on the Victoria Ca

Settle." Alludes to papers of Messrs. Dawkins and Tiddeman, stating the clay overlying the lower cave earth to be of glacial origin, which the author thinks improbable, the laminated clay occurring "in the cave on the surface at a point where it can only be of most recent origin, near the dome which terminates in a 'pot-hole,' by which" the clay has entered, derived from the glacial clays lying in hollows, on the surface of the ground, as are similar clays, occurring in other caverns where a theory of glacial introduction would be possible. The author also differs from Mr. Tiddeman, who ascribes the base of the talus at the entrance to glacial age, in believing it to have been formed by matter falling from above, finding in that part of the talus a smoothly rounded limestone boulder like those occurring in "pot-holes," and from other reasons, the whole resting on the original entrance to the cave, which afterwards became covered up.

SPENCE, Mr., F.C.S., communicated the fact to the Society that an African diamond immersed in fine clay in a small crucible, subjected to a heat, at no time beyond cherry red, entirely volatized and disappeared after three days' exposure.

WILLIAMSON, Prof. (April 1st, p. 106), alluded to the species of *Asterophyllites*, considered to belong to *Sphenophyllum* by Renault, and remarked on the very close affinity of the two genera.

DAWKINS, W. Boyd (April 15th, p. 111), Secretary of the Committee of the British Association for carrying on the explorations of Victoria Cave, replies to Mr. W. Brockbank's paper, mentioned above, reiterating his belief that the cave-bed at the bottom is pre-glacial, and stating that so far from 100 tons of earth having fallen on the day of Mr. Brockbank's visit, probably the mass weighed less than a ton.

PLANT, John, F.G.S. (April 21st, p. 146.) "Notes on a Fossil Spider in Ironstone of the Coal-measures." Discovered by Mr. Elliott Hollier, in ironstone nodules in Dudley Coal-field, described by Mr. H. Woodward as *Eophrynus Prestvicii* in GEOL. MAG. 1871.

C. E. De R.

REVIEWS.

I.—A BRIEF ACCOUNT OF M. DELESSE'S BOOK, "LITHOLOGIE DU FOND DES MERS," published under the auspices of the Minister of Marine and of Public Works. (Paris: E. Lacroix, 1871.)

By G. A. LEBOUR, F.G.S.

M. DELESSE divides the matter of his important work into the five following parts:—

I.—*Preliminaries.*

Methods adopted in studying the deposits

Orography of France and of its submarine shores.

II.—*Principal agents of the submarine deposits.*

Organic agents

Inorganic agents	external . . .	Atmosphere. Fresh and brackish waters. Sea.
	internal . . .	Subterranean waters Eruptions. Dislocations.

III.—*Marine Deposits of the French Coasts.*
Littoral and submarine deposits.
Distribution of Mollusca.
IV.—*Lithology of the principal Seas of the Globe.*
France.—New World.—Old World.
V.—*France at different Geological Epochs.*
Deposits of the old French seas.
Deformations undergone by these deposits.

It will be seen that under each of these heads can be grouped a very considerable number of geological facts and problems, and the author is not one likely to slur over his work. Indeed, he appears to have not only collected all the available evidence as to the nature of the bottoms at innumerable points of the ocean, but to have made in person, or through his assistants, analyses of a large proportion of the soundings obtained. As is natural in a national work, those portions of it which are immediately connected with France are treated in a much more exhaustive manner than those relating to other parts of the world. It is partly for this reason that I know that M. Delesse is anxious that English geologists should be made acquainted with the less extensive but equally important pages of his work which relate to the seas of Britain, and with the more general results of his investigations, which must be of interest to geologists of every country. My task, therefore, in the present article is simply that of laying before the readers of the GEOLOGICAL MAGAZINE as fair an abstract as I am able of those points just referred to, giving the author's views without criticism or comment, leaving such disquisitions for a future occasion.

I.—The methods employed in studying the deposits need not detain us. They consist in ordinary chemical analysis, sifting and washing. One point, however, is worth noting in passing. It is that in the residue of washings, even of very argillaceous deposits, a great abundance of silex, and especially of quartz,[1] is invariably present. This fact gives one a good idea of the complexity of origin of most of the bottoms, and cannot fail to add greatly to the difficulty experienced in tracing them back to their parent rocks.

II.—Among the organic agencies contributing to the formation of marine deposits, M. Delesse numbers not only the enormous amount of *débris* due to mollusca and marine vegetables, but also such a slow and comparatively weak action as that of boring shells and echinoderms in eroding the walls of the sea, and the cumulative action of corals and other stationary organisms. "In the sea," he says, "vegetation carries on a slow degradation of the sides. It must especially deeply corrode calcareous rocks, as has been shown to be the case in the Swiss lakes. In course of time, lacustrine or marine plants produce, in short, destructive effects analogous to those of terrestrial plants."

III.—These effects are, however, tolerably well understood, and it is with regard to the inorganic agents that our author holds less generally received opinions. As far, indeed, as the ordinary sources of denudation are concerned—wind, rain, rivers, glaciers, and breakers, etc. —the ordinary views are clearly defined by him, and much valuable tabulated detail is given respecting the velocity, sediment, etc., of the principal rivers of France, in a manner which makes one wish that something of the kind were done for Great Britain.

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[1] M. Delesse does not seem to have used polarized light in ascertaining the flinty or quartzose origin of grains of sand. (See *Nature*, 9th May, 1872.)

M. Delesse's Chapter viii. however is a distinct contribution to submarine geology, and deserves to be given in his own words. It treats of the *internal agents*, and forms a clear *exposé* of the views now held by the leading French geologists on an important branch of Dynamical Geology:—

"These," he says, "can produce equally effects either of erosion or of transport; more often even they bring into the sea and into sea-deposits mineral substances coming from the interior of the globe. These agents are *subterranean waters, eruptions*, and *dislocations*.[1]

"I.—*Subterranean Waters.*

The waters which penetrate into the earth obey the laws of gravity, descend slowly through the pores or interstices of the rocks, and end by re-uniting into subterranean sheets. Hidden from our eyes, they flow into the beds of rivers and into sea-basins; sometimes they fall into them at their upper portions, sometimes low down.

The infiltrations of subterranean sheets of water into the basin of the ocean take place incessantly, and on an immense scale; they even represent a very considerable proportion of the meteoric waters which fall on the emerged portion of our globe. Moreover, they take place, not only towards the upper level of the ocean, but also along its sides and down to the lowest depths.

Now, the subterranean sheets of water are charged with mineral substances, which are furnished by the rocks through which they pass, and these they bring to the ocean. In particular do they bring silica and carbonate of lime, which the sponges and molluscs afterwards concentrate in deposits.

Sometimes they are sufficiently charged with carbonate of lime to produce calcareous tuffs, like those which are now being formed at the bottom of rivers and on the sea-coasts.

The mineral substances become, besides, more abundant in the underground sheets of water according as the latter contain more carbonic acid, as they have a higher temperature, and consequently as they reach a greater depth. The underground sheets of water therefore introduce mineral substances into the ocean, and they must play a rather important part in the formation of marine deposits.

Independently of these submarine infiltrations, produced by waters falling on the surface of the globe, and penetrating its crust, there are others in existence which are due to mineral waters of an eruptive nature, and disengaging themselves on the contrary from its interior.

These last are local; for they can only come to the day through the fissures of the earth's crust; but their temperature is high, so that they hold a large proportion of substances in solution. They are very numerous in volcanic regions; besides, their outpour becomes very abundant when eruptions or earthquakes take place.

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[1] The *subject has since been enlarged on by* M. Daubrée in a paper noticed in the *Geological Magazine, 1873, Vol. X. p. 472.*

The formation of mountain-chains has also given rise to extraordinary activity in mineral springs; moreover, when rocks have been raised from the bottom of the sea and brought back above its surface, the waters which saturated them must have flowed underground, giving rise to powerful infiltrations.

However it may be, the substances incessantly introduced into the sea by mineral waters have subsequently been separated by organized beings, and also by chemical precipitation. Beds of carbonate of magnesia or dolomite have been doubtless formed in the latter way, both at the present time and in former epochs. Such is also the most probable origin of gypsum, which may be attributed to the freeing of sulphuretted hydrogen, or else of sulphated mineral waters; in most cases, besides, gypsum appears to have been deposited in lakes.

"II.—*Eruptions.*

Eruptions, those in particular which occur at the bottom of the sea, contribute in a very efficient manner to the formation of marine deposits, and even give rise to strata; for they accumulate a great quantity of *débris*, which are afterwards re-assorted by waves and tides, and then carried off by currents.

The geological study of rocks shows well all the importance of these eruptions, and often even marine beds are almost entirely composed of *débris* of rocks which have been thrown up from the interior of the earth. This is particularly observable in trappean, basaltic, and trachytic tuffs, and for all tuffs, in short, which are formed from volcanic rocks.

At the present day submarine eruptions are rather rare, and, besides, they only take place at a small number of points; they must, however, be taken into account in studying the lithology of our sea-bottoms. They give, indeed, deposits resulting from volcanic ejectamenta, and therefore entirely distinct from those which are habitually formed. These deposits group themselves in the neighbourhood of the volcanos which produce them; when, however, the volcanic ejectamenta are in the state of floating pumice, of minute *débris*, of ash or of mud, they may easily be transported by currents, and then be spread to very great distances.

As regards France, we know no submarine volcanos near our coasts, either in the ocean or the Mediterranean; but in the latter sea, the islands of Julia and Santorin enable one to judge of the importance of the effects occasioned by recent submarine eruptions.

Now there are also salses or mud-volcanos which specially eject gases, water, and mud, and which in consequence give rise to beds of clay. Such volcanos are found either at the surface of the land or at the sea-bottom. In the Caspian, more particularly, their ejectamenta have sometimes formed shoals, and even islands of mud, [illegible]ing to the surface of the water.

The mud which is being deposited at the present time in our lakes *at the bottom of* our seas nearly always contains carbonate of lime which is specially secreted by the molluscs peopling their waters. On the other hand, the mud ejected by salses is not mixed with *débris* of molluscs, and the carbonic acid by which it is accompanied can, besides, easily dissolve the carbonate of lime contained by it. It will easily be perceived, then, that when a bed of pure clay is met with intercalated between fossiliferous beds, there is some probability that it has been ejected from the interior of the earth, either by mud volcanos, or by any other eruptive phenomenon. It is noteworthy, moreover, that clay-beds being impervious to subterranean waters, they could not completely lose their carbonate of lime by solution; therefore, when they do not contain any now, it is pretty certain that they had none originally.

Let us observe, besides, that the muddy ejectamenta must, like all eruptive phenomena, have been more frequent during the geological periods preceding the present one.

"III. *Dislocations.*

The terrestrial crust is still subject to accidental dislocations, occasioned by earthquakes, by eruptive phenomena, and, at rare intervals, by the rising and sinking which accompany the upheaval of mountain systems.

The basin which contains the ocean is liable, then, to destruction analogous to that to be observed on land. This destruction is produced at once by the forces acting in the interior of the earth, and by the sea itself, which is suddenly put into motion. This being so, the *débris* derived from the bed of the ocean, and those which are redistributed by the agitation of the waters, must concur to form marine deposits.

If one considers earthquakes, for instance, they are felt very sensibly by ships, and the sea can transmit them enormous distances.

When the earth's crust is alternately rising and sinking, its oscillations engender forced waves, or waves of translation, which have a great power, and which can attain an exceptional height. At the time of the earthquake at Concepcion, in Chile, it was specially noted that the wave thus put in motion was propagated as far as the Hawaii Islands, a distance of more than 683 miles.

In France earthquakes are tolerably frequent; they are felt especially in the Gulf of Gascony and in the Mediterranean: but they have not much influence on the formation of the marine deposits of our coasts.

If we go back to previous eras, when the mountain-chains suddenly rose from the bottom of the sea, they certainly accumulated an immense quantity of *débris;* they also threw back towards the surface subterranean waters charged with mud, which, spreading over the submerged as well as the emerged land, deposited thick beds of clay; at the same time they gave birth to waves of such power and height as it is difficult to realize.

Without leaving French territory, the dislocations which gave to the Pyrenees and to the Alps their principal relief suddenly brought into play tremendous *masses of water,* by the side of which our *highest waves are, so to speak, of* no account. They formed thick deposits, which on the coasts were chiefly composed of sands or of conglomerates; they produced effects of erosion and of transport which worked over a vast extent of ground and with exceptional energy, so that there resulted from them a veritable cataclysm."

The word just written "cataclysm," and the frequent recurrence in the last few paragraphs of the adverb "suddenly," in reference to such phenomena as the upheaval of mountain-chains, will doubtless jar upon the ears of most British geologists; but it must be remembered that cataclysmal geology still, with certain modifications of course, holds its own across the Channel. It is, however, a welcome recognition of the great effects of subaërial denudation by M. Delesse, that he lays it down as an axiom (p. 139, vol. i.) that the bottom of the sea is always, and necessarily, less furrowed and sculptured than the surface of the land.

Leaving for the present the other subjects treated of at length by M. Delesse, I think I cannot do better than give briefly the results of his investigations of the sea-bottom off our own coasts. The maps accompanying his work will show the details which space will not permit me to refer to here.

With regard to the orography of the "Océan Britannique," as M. Delesse calls our seas (excepting the Channel and the North Sea), he shows how Britain and Ireland stand on a sort of terrace, the boundary of which on the Atlantic side coincides sufficiently exactly with the 600 feet contour line (*below* sea-level, of course), in such a manner that were the British Islands elevated 600 feet, they would be joined to France and to Denmark, but the Faroë Islands, Iceland, and Rockall would still be islands. As is natural in the neighbourhood of a mountainous centre, the surface of this terrace is very irregular around Scotland; especially there are to be noted two valleys extending under the sea to the West of Scotland, separating it on the one hand from the Hebrides, and on the other from Ireland.

The littoral deposits of the south of England are naturally very similar to those of the north of France, and are equally referable to the geological formations along the coast-line. Among the submarine deposits sand stands pre-eminent. Next in point of frequency comes gravel, which is found in oddly-shaped masses at various points, especially to the west of the British Isles, south of Cork in the Bristol Channel, between Land's End and the Sorlingues Islands, and also in the Channel. In the eastern part of the Channel gravel occupies a large surface, and seems to unite the Greensand of Upper Normandy to that of England. In the Bristol Channel and to the south of Ireland M. Delesse suggests that the origin of the gravel is probably a submarine outcrop of Old Red Sandstone; south of Exmouth and of Star Point it may be referred to the prolongation under the sea of the arenaceous Triassic beds.

The distribution of mud is next investigated. The patches of mud-bottom in the Channel are due doubtless to the Palæozoic schists, the Triassic clays, the Liassic marls, and the Eocene clays. [illegible]ey can be traced from Dover to the Lizard.

[illegible]f *the west coast* of Ireland a few patches only are to be found, they are near Co. Donegal, in Galway and Dingle Bays; south and east of Ireland, however, large surfaces with irregular outlines are formed of mud. Mud-bottoms also are found in plenty around Scotland. In these cases, submarine decomposition of unknown outcrops is pointed to as their origin.

The points of the sea-bottom which are bare, or rather where the soundings could discover nothing but rock, are marked by the black areas on the maps, and a study of these with reference to deep-water currents would doubtless throw much light on their origin. The nature of the rock itself is in these cases naturally often doubtful.

The discussion of the last portion of M. Delesse's book, consisting chiefly of an attempt, generally successful, to reconstruct the physical geography of France at various epochs in its geological history, must be for the present deferred.

II.—SCIENCE PRIMERS. Edited by Professors HUXLEY, ROSCOE, and BALFOUR STEWART. Part V. GEOLOGY. By Prof. GEIKIE, LL.D., F.R.S. 12mo., pp. 130. (London: Macmillan & Co., 1874.)

THIS little primer is one of a numerous series, and is an excellent introduction for very young children to the vast subject of Geological Science.

The object of this series is to give its juvenile readers an insight into the main facts of the different branches of science, in as simple a way as possible, illustrating them with common and familiar examples of every-day occurrence.

This plan is well carried out by Prof. Geikie in the Part before us.

The author first treats of the three different kind of rocks—sedimentary, organic, and igneous—how and by what agencies each was formed, and why fossils occur in the first two. He next takes the crust of the earth, shows that it has been raised, depressed, and contorted; how mountains have been formed, and "how the rocks of the crust tell the history of the earth."

Having thus brought his young readers to the threshold of Geological Science, Prof. Geikie bids them adieu, leaving them, if so disposed, to enter and discover the endless store within.

The style is throughout easy, and the language simple. Every fact is so clearly expressed and lucidly explained as to be entirely within the comprehension of any child of ordinary capacity. There are, besides, numerous well-executed woodcuts, in illustration of all the principal points in the work.

If we may judge of the series from the Part before us, we should say that it is well qualified to supply the want, beginning to be felt, now that Natural Science is becoming day by day more popular, and more widely taught, of some good though juvenile works on its different branches. Should the School Board ever introduce the teaching of Natural Science into their system of education, we would most heartily recommend these little books to their consideration.

We should not omit to add that collections containing twenty-two geological specimens, neatly arranged in a polished deal box, prepared expressly to illustrate the Geological Primer (price 10*s.* 6*d.*) are supplied by Mr. James R. Gregory, 15, Russell Street, Covent Garden, London, or may be had of Messrs. Macmillan, the publishers.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I.—December 3, 1873.—Joseph Prestwich, Esq., F.R.S., Vice-President, in the Chair. The following communications were read:—

1. "Notes on the Structure sometimes developed in Chalk." By H. George Fordham, Esq., F.G.S.

After referring to Mr. Mortimer's paper on the same subject (see Quart. Journ. Geol. Soc. vol. xxix. p. 417), the author stated that in a pit near Ashwell the "Lower Chalk without flints" exhibits a bed of a concretionary nature, the concretions in which are marked nearly all over with lines. The lines are found only on the concretions and in their immediate neighbourhood. The fossils in the bed are invariably crushed, as if by pressure. The author believes that the striæ are due to an incipient crystallization arising from the formation of the concretions; and in support of this view he adduced a specimen of iron pyrites from the chalk of Beachy Head, attached to which is a small portion of very hard striated chalk, and suggested that the crystallization of the pyrites had induced a crystallization in the chalk. He considers, however, that in some places an almost identical structure may be due to slickensides, but only in very broken and faulted beds.

Discussion.—Mr. Seeley observed that the structure was familiar to all. If it were due to crystallization, whether incipient or otherwise, he wished to know to what combination with lime for a base the form of the crystals was due. He thought that a certain amount of phosphate of lime was present in the concretions, but was absent in similar specimens in the Upper Chalk, so that it appeared as if the same cause could not apply in both. The striæ were not, he thought, due to slipping or to organic growth, but might arise from some alteration in the character of the chalk.

Mr. Evans observed that the striæ appeared to be due to two causes—crystallization, whether incipient or destroyed, and slickensides. He thought that in the Ashwell specimens much was owing to the hard nodules resisting pressure better than the surrounding chalk, which, in being condensed, passed over their surfaces and produced a kind of slickensides. The same appeared to have been the case with the nodule of pyrites.

Mr. Forbes remarked that an inspection of the specimens on the table convinced him that in several instances the structure was due to slickensides, but that in others traces of a very different structure were visible, which he imagined was due to crystallization, the carbonate of lime having most probably assumed the form of Aragonite, which, owing to its instability, had lost its crystalline lustre, and assumed a mealy or chalky appearance.

Mr. Judd thought that the contrast between the two papers communicated to the Society was striking. This was mainly due to the difference in the Chalk of Yorkshire and that of the south of England. The abundance of this structure in Yorkshire might well have caused Mr. Mortimer to connect it with some organic origin for the formation of the Chalk. Its rarity in the south might have led Mr. Fordham to assign another and a chemical cause. He thought that it prevailed most in those parts of the Chalk through which water most readily passed, and considered that in some cases the crystallization had been that of Aragonite, in others that of Calcspar. He commented on the dimorphism of carbonate of lime, which under slightly different conditions assumed different characters; and remarked that, as was the case with many igneous rocks, the structure in the Chalk became more apparent after weathering.

Mr. Meyer remarked that the striæ were most common where nodules were present, and in beds in which the fossils were crushed. So far as he had observed, they were always vertical, and he attributed them to a re-arrangement of the particles of Chalk under pressure.

The Author explained that two of the specimens had been taken from the sides of a fissure, and were actually slickensides. He thought that some of the nodules exhibit traces of internal structure; but it was true that the general direction of the striæ was at right angles to the lines of bedding. He was glad that his remarks had led to so interesting a discussion.

The Chairman suggested that an analysis should be made of the specimens.

2. "A short description of the Geology of the Eastern Province of the Colony of the Cape of Good Hope." By R. Pinchin, Esq., C.E. Communicated by H. W. Bristow, F.R.S., F.G.S.

In this paper, which was illustrated by maps and sections, the author gave the results of his observations on the geology of the above region. The two principal sections described were from Cape Saint Francis across the Great Winterhoek and Langeberg ranges to the lacustrine Triassic rocks near Jansenville, and from Port Elizabeth to Somerset. The lowest rock in the first section is the quartzite of the Great Winterhoek, which is immediately overlain to the northward by clay-shales and sandstones containing Devonian fossils. Beds with similar fossils occur at the Kromme river, Cape St. Francis, and near Uitenhage. A patch of horizontal secondary strata stretches west from the Gamtoos river, overlying the Enon conglomerate in the same way as the Jurassic strata of Uitenhage. They contain no fossils. The Enon conglomerate is seen on the flanks of the higher hills. The northern ranges, Langeberg, Klein Winterhoek, and Zuurbergen, are regarded by the author as formed of rocks belonging to the Carboniferous series, although closely resembling those of the Great Winterhoek in lithological character, except that among them are bands of the peculiar rock described by Bain as "Claystone porphyry," by Wyley as a "Trap conglomerate," by Tate as a "Trap-breccia," and by Atherstone as an "intrusive Trap." Rubidge regarded it as a metamorphic rock; and this view is adopted by the author, who describes it as underlying and overlying the clay-shales, which always separate it from the quartzite, and as passing imperceptibly into the clay-shales. The mottled sandstone or Ecca rock is referred by the author to the Carboniferous series. The author also noticed the occurrence of Tertiary or recent rocks containing remains of Mollusca identical with species now living in the adjacent seas, lying unconformably upon the Devonian and conformably upon the Secondary rocks at various places near the coast.

Discussion.—Prof. Phillips was struck by the manner in which our system and nomenclature was applicable to a country so remote as the Cape. He was inclined to question the metamorphism of the nodules and concretions in the clay-shales into granite, and commented on the supposed interstratification of the metamorphic rocks among unaltered shales. The correlation of the rocks at the Cape with the Devonian and Carboniferous rocks of Europe he thought most interesting, especially taking into account the distance between the two localities.

Prof. Tennant made some remarks on the gratitude due to the first geological observers in South Africa, who had, by the discovery of the Diamond-fields, so materially added to the wealth of the colony. During the last month he had seen no less than £100,000 worth of diamonds brought over by three persons. At present some twenty thousand persons were employed in the fields, and the diamonds were equal to any in the world. The trap-rocks in South Africa were as various in their character as those in this country, and this variety might well lead to speculation as to their origin.

3. "On the Mud-craters and Geological Structure of the Mekran Coast." By Lieut. A. W. Stiffe, F.R.A.S. Communicated by Prof. Ramsay, F.R.S., V.P.G.S.

The coast of Mekran, extending from near the western frontier of India to the mouth of the Persian Gulf, was stated by the author to be a nearly rainless district, consisting of clay plains with precipitous tabular hills, the former veined here and there with crystalline gypsum, the latter composed of clay capped and sometimes interstratified with coarse, friable, fossiliferous, calcareous strata, from 5 to 30 feet thick, supposed to be of Miocene age, and all horizontal or nearly so, except at the extreme east and west, where the strata are inclined at an angle of from 40° to 60°. Along the coast there are no distinct traces of volcanic action, but on the north coast of the Persian Gulf a similar formation has been much disturbed by the protrusion of recent volcanic material; near Jâshak to the west there is a hot mineral spring, and near Karâchi there are springs of pure hot water. The author described the mode in which denudation is effected in this region by occasional heavy rains, and by the constant action of the sea upon the coast, and then noticed the occurrence, within a few miles of the shore, of numerous peculiar mud-craters, forming hills varying in height from 20 to 300 or 400 feet above the plain, of a regular conical form, with truncated tops, and the sides sloping at an angle of about 40°. The summits of these hills present a circular cup with a narrow border, filled with semifluid mud, which occasionally flows slowly over the margin of the crater. The author considered that the conical hills have been formed solely by these overflows. He believed that a small shoal occurring off the coast near Jâshak might be produced by one of these craters, and was inclined to ascribe their existence to hydrostatic pressure rather than to volcanic action, especially as, by the concurrent testimony of several natives, the discharge from the craters is greater during spring tides. The thickness of the clay forming the plain is probably very considerable; it extends for some miles from the shore, sinking gradually to 20 or 30 fathoms, when there is a sudden and often precipitous descent to a depth of 300 or 400 fathoms. The author suggested that, since the deposition of the Miocene beds, the great submarine cliff may have been raised above the sea; that the land was then depressed to near its present level, causing the removal of the beds to the present coast line, and that a further depression followed by upheaval gave origin to the inland cliffs. Evidence of the last depression is fur-[illegible]ished by the presence of borings of lithodomous mollusca in the [illegible]s *considerably above* the present sea-level.

Discussion.—Mr. Evans thought that the fact of the mud from some of the cones having ceased to flow was in favour of the theory of their being due to hydrostatic action, the outflow ceasing when the pressure was insufficient to overcome the resistance, and a fresh vent being found elsewhere.

Mr. Forbes had frequently observed the mud-craters of Peru, which were undoubtedly due to volcanic action, though in many instances the outflow was cold, or nearly so. In the cases described by the author it was, however, possible that they might be due to another cause.

Prof. Phillips mentioned a spring which rose through mud in Bridlington Harbour, and from which the outflow was greatest at low water; but the spring tides in the Persian Gulf might, on the contrary, effect a rise in the mud-craters by obstructing some passage by which mud was discharged into the sea. Were this so, the upward movement in the crater would on each occasion probably occur somewhat later than the high tides.

Mr. Seeley remarked on the presence of undoubted volcanic action in the district, in the shape of hot springs, &c., and therefore questioned the propriety of bringing in hydrostatic pressure to account for the phenomena.

Mr. Miller cited the mud-volcanos of Iceland as instances of pure volcanic action, and drew a distinction between the occurrence of mud-craters near the sea and at a distance from it.

The Author, in reply, observed that he had merely suggested the possibility of the outflow being due to hydrostatic pressure, and did not insist upon it. He stated that there was ample evidence of volcanic action at a distance of 200 or 300 miles from the district he had described.

II.— December 17th, 1873.—Prof. Ramsay, F.R.S., Vice-President, in the Chair. The following communications were read:—

1. "Observations on some Features in the Physical Geology of the Outer Himalayan Region of the Upper Punjâb, India." By A. B. Wynne, Esq., F.G.S.

The district of the Upper Punjâb described by the author consists of crystalline, granitoid, syenitic, and schistose rocks far in among the hills, succeeded by slates and limestones, possibly of Silurian age, unconformably overlain by Triassic and perhaps older rocks, which are in their turn unconformably succeeded by a series of mutually conformable Jurassic, Cretaceous, and Nummulitic Limestones and shaly beds. These Secondary and Tertiary beds, which are chiefly limestones, are called the "Hill Limestones." Beyond these comes a zone of hills and broken plains, composed of sandstones, clays, and conglomerates, of great thickness and of Tertiary age (Eocene and Miocene), which the author calls the "Murree beds." This belt passes generally along the whole southern foot of the Himalayas, from Assam to Afghanistân. In the district described by the author it is bounded on the south by the Salt Range, beyond which stretch the deserts of the Punjâb and Sind.

The outer Tertiary belt presents a gradation towards the hill character. Among the rocks of the Murree zone there are harder beds than elsewhere; limestones occasionally appear, sometimes like those of the hill-beds, and the Hill Nummulitic Limestones may have alternated in their upper part with the Murree beds. The Nummulitic Limestones of the Salt Range, containing large Bivalves and Gasteropoda, were probably of shallow-water origin, whilst the diminutive organisms *of the Hill* Nummulitic Limestone inhabited *greater depths.*

Contortion of the strata is a common feature of the country, affecting some of the newest Tertiary beds so as to place them in a vertical position, and almost everywhere throwing the rocks into folds, producing in many cases inversions of the strata.

The author compares these rocks with those of the Simla area described by Mr. Medlicott, who found there two strong unconformities, namely, between his Siwalik and Nalum, and Nalum and Subathu groups, and regarded the whole of the beds of the outer Tertiary detrital zone from the base of the Subathu group upwards as discordant to the Himalayan or Hill-series and to each other.

The junction of the newer Tertiaries with the rocks forming the higher hills of the outer Himalaya, both in the Simla area and in the outer Punjâb, is marked by disturbance, distortion, and inversion or abnormal superposition in the Tertiary strata along the contact. In the Upper Punjâb the junction follows a curved line, running nearly east and west to the north of Rawul Pindee, then describing an angle which closely follows the great bend of the Jhilam river near Mozufferabad, it runs more or less in a south-easterly direction through Kashmere towards Simla. This junction line is inseparably connected with the causation of the great mountain-chains: it shows a parallelism to the axes of the outer ranges, and is chiefly due to intensity of disturbance, the result of lateral pressure.

The author also refers to the difference existing between the geology of the outer Himalayan region and that of the Salt Range, as being similar to that which obtains between the Alpine and extra-Alpine characters of European rock-groups, and suggests that the recurrence of such similar features at such distances may indicate a connexion between the former conditions of deposition and the early history of the great chains themselves.

DISCUSSION.—Mr. Drew gave some further explanation of the author's views and of the geology of the district.

The Chairman agreed with the author as to the analogy between the outer ridges of the Himalayas and those of the Alps, and also as to the difficulty in such cases of distinguishing between an inversion and a fault. From the different conditions as to metamorphism of the Miocene and Eocene rocks in the Alps, he had been led to question the fact of the inversion, and now found that most Swiss geologists had come round to the opinion that the present position of the beds was not due to mere inversion, but to actual dislocation. He thought this might also prove to be the case in the Himalayas.

2. "On the Mode of Occurrence of Diamonds in South Africa." By E. J. Dunn, Esq. Communicated by Prof. Ramsay, F.R.S., V.P.G.S.

In this paper the author stated that the diamonds of South Africa occur in peculiar circular areas, which he regards as "pipes," which formerly constituted the connexion between molten matter below and surface volcanos. The surrounding country consists of horizontal shales, through which these pipes ascend nearly vertically, bending *upwards* the edges of the shales at the contact. The rock occupying these pipes was regarded by the author as probably Gabbro, although in a very altered condition. Intercalated between the shale-beds there are sheets of dolerite, etc., and dykes of the same rocks also intersect the shales at frequent intervals. Within the pipes there are unaltered nodules of the same dolerite. With regard to the relation of the diamonds to the rock of the pipes in which they are found, the author stated that he thought it probable that the latter was only the agent in bringing them to the surface, a large proportion of the diamonds found consisting of fragments. At the same time he remarked that each pipe furnished diamonds of a different character from those found in other pipes.

DISCUSSION.—Mr. Maskelyne complimented the author on the contribution which he had made to geological science, by showing that the rock in which the diamonds occur is confined to the pipes such as he had described. He was able, from specimens which he had examined, to state positively that this certainly igneous rock differed essentially from the dolerites and other igneous rocks in the neighbourhood. He would not attempt to give it a name, whether Gabbro, Euphotide, or any other designation. The materials, so far as they could be determined in their present altered condition, were such as would not build up any one of the known rocks. There were garnets and minerals resembling clinochlore, smaragdite, phlogopite, diallage, and calcite, and apparently another mineral entirely serpentinized. The diallage was the true diallage, viz. a mineral of augitic type. The mineral resembling clinochlore was, he had proved, vermiculite, and the phlogopite was not improbably Jeffreysite. The calcite had been thought to have been derived from the decomposition of augitic silicates, but this he doubted. One specimen, from a depth of 130 feet, exhibited a completely serpentinous metamorphosis, which had involved one mineral as yet undetermined, but probably enstatite. The absence of felspars in all the rocks but one was singular; in one specimen from Bultfontein there was, however, an abundance of kaolinite, proving the original presence of a felspar. He thought that the fracture of the diamonds might be due to the breaking up of the rocks in which they are now found. A fact pointed out by the late Prof. Rose, viz. that the octahedral faces of diamonds became grooved after burning by triangular striations, was of great importance in considering the changes these rock-fragments had undergone, as many of the diamonds from the upper beds had their surface striated in this manner. It would be a question of interest to observe whether those from the lower depths were similarly marked and equally shattered.

Mr. Forbes observed that, owing to his not having had the opportunity of examining the rocks in question, he could not speak as to their nature; but as he looked upon the rock Gabbro as being in the main composed of triclinic felspar with diallage, he could not regard any of the rock-specimens shown as entitled to this name, especially as they, as a rule, were even devoid of felspar. The black rock, found deepest, appeared to him to resemble one of the altered basalts in which Zirkel had shown that the olivine was changed into a peculiar greenish serpentine-like mineral.

Mr. Dunn, in reply, stated that he had merely made use of the term Gabbro as a provisional name. There could, he thought, be no doubt of the volcanic origin of the rock; and moreover, near Bultfontein and elsewhere, there were sheets and dykes of dolerite, but quite different from the rocks in the pipes. Some of the fragments in the matrix were fragments of shale, mica-schist, and hornblende, which had probably been brought up into the pipes from below.

The Chairman remarked on the wide application of the term Gabbro, which could hardly be said to imply any distinct mineralogical character. Looking at the question broadly, the facts seemed to be, that among nearly horizontal shales there were patches of rock of approximately circular form, with the shale turned up around their edges, and altered for a certain distance. The appearances were therefore those of the extrusion of a heated or molten body by expansion from below; and possibly, as the author suggested, other traces of eruption had been removed by subsequent denudation. He could not regard the rocks in the pipes as in any way metamorphic, in the usual acceptation of the term. Though the volcanic origin of those rocks might be accepted, he thought it more probable that the diamonds were brought up from some subterranean metamorphosed rock, than generated in the lava.

III.—January 7th, 1874. Prof. Ramsay, V.P.R.S., Vice-President, in the Chair. The following communications were read:—

1. "The Origin of some of the Lake-basins of Cumberland." First Paper. By J. Clifton Ward, Esq., F.G.S., Assoc. R.S.M.

After referring to the fact that the question of the origin of lake-basins cannot be satisfactorily discussed unless the depth of the lakes and the heights of the mountains are brought before the mind's eye in their natural proportions, the author sketched out the physical geography of the lakes under discussion (Derwentwater, Bassenthwaite, Buttermere, Crummock, and Loweswater), and pointed out what must have been their original size and shape before they were filled up to the extent they now are. These lakes were not moraine-dammed, but true rock-basins. The belief that the present Lake-district scenery was the result of the sculpturing of atmospheric powers, such as we see now in operation, varied by climatal changes and changes in the height of the district above the sea, was enforced, and the opinion given that the work of elaboration of the lake-country scenery has been going on ever since Carboniferous or pre-Carboniferous times. The lake-hollows represented almost the last rock-shavings removed by Nature's tools. What were the special tools producing these hollows? There being no evidence of their production by marine action or by running water, since they do not lie in synclinal troughs, nor along lines of fissuring and faulting, and cannot be supposed to be special areas of depression, it remained to see how far Professor Ramsay's theory accounted for their origin. The course of the old Borrowdale glacier was then fully traced out, and the power the numerous tributary glaciers had of helping to urge on the ice over the long extent of flat ground from Seathwaite to the lower end of Bassenthwaite Lake, commented on. The same was done with regard to the Buttermere and Ireton glacier, and the depths of the lakes, width and form of the valleys, and thickness of the ice shown by numerous transverse and longitudinal sections drawn to scale. When all the evidence was considered—the fact of the lake-hollows under examination being but long shallow troughs, the thickness of the ice which moved along the valleys in which the lakes now lie, the agreement of the deepest parts of the lakes with the points at which, from the confluence of several ice-streams and the narrowing of the valley, the onward pressure of the ice must have been greatest,—the conclusion was arrived at that Prof. Ramsay's theory was fully supported by these cases, and that the immediate cause of the present lake-basins was the onward movement of the old glaciers, ploughing up their beds to this slight depth. It was pointed out that since the general form of the Buttermere and Crummock valley was that of a round-bottomed basin, as seen in transverse section, the effect of the ice was merely a slight deepening of the basin or the formation of a smaller basin of similar form at the bottom of the larger; whereas in the case of the Derwentwater and Bassenthwaite valley, which in transverse section was a wide flat-bottomed pan, the action was to form long shallow grooves at the bottom of the pan. This consideration was thought to explain the fact of the greater depth of Buttermere and Crummock than of Derwentwater and Bassenthwaite, although the size and thickness of the old glacier in the former case was probably less than in the latter. In conclusion, the author stated that he hoped to test the results obtained in these cases by bringing forward in a future paper like details of Wastwater and other lakes and mountains in the district.

Discussion.—Mr. Campbell said that he had listened with great pleasure to the able paper of the author. He was not himself acquainted with the Lake-district, but he knew many similar districts in which similar phenomena existed. He agreed with the author's conclusion, that these lake-basins were the result of glacial erosion. But if ice could do so much it might have done more. In confirmation of the author's views, Mr. Campbell said that in the Caucasus there are very few lakes. He had found no glacial phenomena in the whole range, except one small moraine near the only lake in Daghistan.

Mr. Evans inquired what effect the varying hardness of the strata, their trend and dip, might have had on the formation of the basins, and how the presence of islands was to be explained. He mentioned that at the present day the rainfall at Seathwaite was in some years nearly 200 inches, which, if there were sufficient cold, would suffice even now for an enormous supply of ice.

Mr. Seeley inquired whether the position of the lake-basins in the supposed glacier had any definite relation to the positions of smaller affluent glaciers, and whether the lake-basins were to be attributed to that relation.

Mr. Godwin-Austen remarked on the acceptance which the Chairman's views had received, and the support which they were receiving. There was little doubt of the former existence of ice over a large portion of this part of Europe, but whether it would have existed in such thickness as was required by some geologists was another question. He doubted as to the power of glaciers to drive ice forward to any great extent over land either up a slope or over a horizontal space. He considered that the paper would add a great interest to the country to which it related.

Capt. Douglas Galton disputed the power of ice to act in a manner materially different from that of water. Owing to the friction of the ice at the bottom of a glacier, he thought its flow would be so much retarded that its excavating power would be almost annihilated.

The Author, in reply, stated that the basins in all the cases he had cited were excavated in the Skiddaw slate, the hardness of which was nearly uniform. The dip of the strata was very variable, but he could not point to any spot where the depth of the lake was connected with the dip. The islands in Derwentwater might be the result of an old moraine left by the glaciers in retreating up the valley. The position of the lakes was in the direct line of the principal glaciers. The thickness of the ice was proved by the existence of scratches along the sides of the valleys, such as could not have been produced in any other way. The probability was that the ice had been even thicker than shown by these marks. Though the laws of motion of ice were the same as those of water, yet the action of a hard body was of necessity different from that of a liquid.

The Chairman was so accustomed to meet with papers such as this, confirming his original views, that he was almost becoming weary of the subject. He considered, however, that the sections given by the author on a true scale were of very great value, as calculated to give a correct idea of the actual phenomena, and as showing the value of De la Beche's maxims with regard to such diagrams. He inquired whether there could be any difficulty in a body of ice some thousands of feet in thickness cutting out such inconsiderable hollows as those shown, just in the same manner as running water would excavate its channel more deeply at one spot than another, if from local circumstances the rapidity of its motion were increased.

2. "On the Traces of a *Great Ice-sheet* in the Southern part of the *Lake-district and in North Wales.*" By D. Mackintosh, Esq., F.G.S.

In this paper the author brought forward the evidence which seems to him to establish the existence in the southern part of the Lake-district of a "valley-ignoring and ridge-concealing ice-sheet." With regard to ice-marks, he distinguished between primary striæ and those produced at a subsequent period, and stated that in the Lake-district the direction of the primary striæ generally coincides with that of the action by which ***roches moutonnées*** have been produced. He gave a table of the direction of ice-marks observed by him in the district under notice, and stated that about Windermere and Ambleside the general direction is nearly N.N.W., round Grasmere between N.W. and N.N.W., north-west and west of Grasmere in upland valleys and on high ridges about N. 30° W., south of Grasmere and in Great Langdale N. 35° W., and in the Coniston district a little W. of N. In many places he recognized an uphill march of the ice. He thought that the iceflow producing these marks might be anterior to the flow from south to north, of which traces are observed in the northern part of the Lake-district, and that its source was probably a vast mass of ice covering many square miles of country north of Far Easdale. The author also referred to the glaciation of North Wales, some of the marks of which, observed by him in a district south of Snowdon, seemed to him to indicate the southerly movement of a great ice-sheet capable of ignoring or crossing deep valleys. He noticed that towards the top of the pass of Llanberis there is a thin covering of drift on the S.W. side, resembling the gravelly *pinnel* of the Lake-district. He also mentioned the occurrence near Llyn Llydan of numerous mounds composed of clay, sand, and fine gravel, the stones having generally been rolled by water, and ascribed their formation to a combination of glacial and marine actions.

DISCUSSION.—Mr. Ward was inclined to regard the scratches in the Lake-district described as due to the confluence of several glaciers, so as to form a large mass of ice, the pressure of which enabled it to travel over the ridges separating the valleys, especially at their lower ends. If the phenomena could be explained in this manner, he thought it needless to invoke the existence of a large general ice-sheet. If such a thing had existed, it must have brought some of the rocks from the north and deposited them in the district, and this was not the case.

Mr. D. C. Davies thought that the author had left some circumstances out of view, especially the difference of dates of the striæ on the Welsh mountains, which had been cut at different times during the elevation and depressions of the land. He instanced the occurrence of fragments of Scotch granite in gravels at an elevation of from 1500 to 2000 feet above the sea.

The Chairman observed that some years ago he had attempted to show that Anglesea had been glaciated by ice that had come from the north in the Cumberland district, and attributed this circumstance to the preponderance of this northern ice over that from the Snowdon range, which was, as it were, set aside by it. He was inclined to think that the Menai Straits, the direction of which coincided with the main lines of glaciation in Anglesea, might be due to the same cause.

3. Notes on some Lamellibranchs from the Budleigh Salterton Pebbles." By Arthur Wyatt Edgell, Esq., F.G.S.

In this paper the author commenced by noticing the accordance between many of the pebbles of Budleigh Salterton and beds occurring on the opposite side of the Channel in Brittany, and then described several species of Lamellibranchiata found in the Budleigh

Salterton pebbles. The species described were:—*Modiolopsis armorici* (Salter), *M. Lebesconti*, sp. n., *Sanguinolites*?, sp. (*contortus*?, Salter), *Aviculopecten Tromelini*, sp. n., *Pterinæa retroflexa* (Hisinger, and three other species, *Palæarca*, sp., *Avicula*, sp., *Cleidophorus*?, sp., *Lunulocardium ventricosum*, sp. n., *Ctenodonta*, sp., and *Orthonota*?, sp.

DISCUSSION.—The Chairman commented on the value of the paper. The distance of the parent rocks, the rolling of the pebbles, and their travelling from south to north, threw considerable light on the physical condition of the Triassic period. If the New Red Sandstone were, as was now generally supposed, of freshwater origin, the information given was of still higher interest.

Mr. Godwin-Austen observed that one of the remarkable features of the Budleigh Salterton beds was the presence of fine sandy deposits, both above and below, which at once suggested a difficult question as to what could have been the condition under which they were deposited. He thought that they might be connected with some glacial action, especially as blocks of porphyry, 25 tons in weight, had been transported from the neighbourhood of Exeter and deposited in the Triassic beds, which could hardly have been effected otherwise than by ice. In the same manner as the shingle of Lake Superior is carried away and redeposited by shore-ice, so he thought it possible that some action of the same kind might during a portion of the New Red Sandstone period have drifted materials off from the French shore of the Triassic lake, and deposited them in this shingle-bed at Budleigh Salterton. In conclusion, he alluded to the loss which the Society had sustained in the death of Professor Louis Agassiz, its distinguished Foreign Member, to whom the now generally accepted term *roches moutonnées*, so often mentioned in the course of the evening, was due.

Mr. Whitaker pointed out that in the slaty rocks at Mevagissey in southern Cornwall, were quartz reefs of similar character to the material of the pebbles at Budleigh Salterton, and recommended a careful examination of these reefs before accepting the Breton origin of the pebbles as conclusively established. The deposit at Budleigh Salterton was, he believed, a lenticular mass of no great extent.

Mr. Etheridge remarked that Mr. Salter had long ago been of opinion that the fossils in the pebbles were of French origin. Mr. Tawney also had examined the beds near Torbay and Babbacombe, and found the lithological characters curiously like those of the pebbles. He did not, however, think that any of the same fossils had been found in them, nor had they been found in the Mevagissey beds in Cornwall.

Mr. Hicks thought that we were going too far in search of the original home of the fossils, which might have been in some rocks destroyed during the formation of the Channel.

GEOLOGISTS' ASSOCIATION.—I.—December 5, 1873.—Henry Woodward, Esq., F.R.S., F.G.S., President, in the Chair.—"On the Yorkshire Oolites." By W. H. Hudleston, Esq., M.A., F.G.S.

The district occupied by beds of Oolitic age in north-east Yorkshire constitutes a mass of elevated land divided into two very unequal lobes by a triangular depressed area, known as the Vale of Pickering, towards which the beds incline. A diagonal of 31 miles from N.E. to S.W. exhibits the beds of the Moorland range resting on the Lias of Robin Hood's Bay, whence they incline towards the Vale of Pickering, newer beds being continually met with as far as the "Kimmeridge Clay" of the Vale. Crossing the Vale towards the Howardian Hills, the previous beds or their equivalents are repeated in inverse order until the Lias of the Vale of York is reached. Dealing with the *Lower Oolites, the* group is essentially arenaceous. *At the eastern termination of the* Moorland range (coast section) these beds have a thickness of 700 feet, mostly sands and shales, nearly devoid of marine mollusca, but rich in plant remains. There are, however, four distinct zones of marine life (well pointed out by Dr. Wright in 1859), which may be made out on the coast, and identified in the transverse valleys of the Moorland range.

1. The Dogger and its associated Sandrock, magnificently developed at Blue Wyke, a sandy Oolite altered into an ironstone, calcic carbonate being replaced by ferrous carbonate; in the case of the shells the original material being now replaced by siderite. Very unequally developed, it sometimes rests on 60 feet of *Striatulus-beds*, sometimes directly on the Upper Lias, and is considered by geologists as forming part of the Murchisonia zone of the Inferior Oolite. It is the source of the principal Oolitic ironstones of Yorkshire. The Rosedale magnetic ore is a local boss occurring in the underlying or Blue Wyke Sands. Fossils are usually small of their kind, and mostly come from the Nerinæa-bed.

2. "The Millepore-bed."—At the point of their maximum development, 300 feet of sands and shales intervene between the Dogger and this bed, which, north of Scarborough, is usually an arenaceous ironstone, but a few miles south of that town becomes the most important calcareous member of the Lower Oolites. *Ceromya Bajociana, Modiola imbricata,* and *Pinna cuneata* are very common shells, whilst *Pholadomya Lœmanni* and *Pygaster semisulcatus* are characteristic; but the author was unable to find any Brachiopods.

The principal fossiliferous bed is an Oolitic marl, altered into an ironstone; the shell matter is gone, and partly replaced by a kind of Kaolin.

3. 100 Feet of Sandrock succeed, and then follows the "Scarborough Limestone" series, consisting of grey marly limestones, alternating with marly shales, varying in thickness from 50 feet at Hundall to three feet at Gristhorp (distance nine miles). *Belemnites giganteus* is a conspicuous fossil. A few specimens of *Ammonites, Blagdeni,* etc., have rarely been found in nodules. *Avicula, Gervillia, Pinna,* extremely abundant. *Trigonia costata* fine. *Trigonia signata* rare. No Brachiopoda, and only species and fragments of Echinodermata. Above the "Scarborough Limestone" series occur 160 feet of shales and sandstones: some of these beds exhibit casts of Myaciform shells. There is also a ferruginous bed containing an oval Unio of moderate size in great abundance.

4. The fourth fossiliferous zone is usually referred to the Cornbrash. More complete marine conditions are apparent. Brachiopoda are abundant. *Ammonites Herveyi* plentiful. A fine suite of fossils were obtained from this bed, which is the last of the Lower Oolites.

In the inland chain S.W. of the Vale of Pickering, the Lower Oolites are much attenuated, amounting to more than 150 feet in the Derwent valley. The types, too, are much altered. At the base resting on the Lias is the "Top-seam" of ironstone, with *Lingula Beanii* and *Orbicula reflexa* on the horizon of the sands of Blue Wyke, which are also further represented by an argillaceous lime d *iron stone, containing* species of *Glyphæa*, similar to those found on the coast. The Dogger proper is poorly developed here, as are the lower shales and sandstones; but the second fossiliferous zone of the Lower Oolites is well represented by an Oolitic Limestone of considerable importance, containing several species characteristic of the lower part of the Inferior Oolite. Above this, and separated by a few feet of sands, are some arenaceous limestones containing *Lima bellula, Pholadomya Theraultii, Rhynchonella spinosa,* a large discoidal Ammonite, etc., perhaps on a level with the *Trigonia-grits* of Cheltenham. This fauna gradually dies out through excess of sandy matter, some shales intervene, and then another group of sands with siliceous limestones occur. These have a tolerably abundant fauna of a peculiar character. *Avicula, Gervillia,* and *Myacites* are especially abundant in these beds, which may possibly be the èquivalent in time of the Cornbrash of the coast, though more estuarine in character.

II.—January 2nd, 1874. Henry Woodward, Esq., F.R.S., etc., President, in the Chair. "On the Nature and Formation of Flint and allied bodies." By M. Hawkins Johnson, Esq., F.G.S.

The object of the paper was to show the nature of several members of a large group of bodies occurring in sedimentary deposits of different ages, and which are generally known as nodules, and described as concretionary. Those specially alluded to were the Septaria from the London and Kimmeridge Clays, the Flints from the Chalk, Iron Pyrites from the Chalk, the Phosphatic nodules of the Gault, the Clay Ironstone nodules of the Carboniferous series, and the Ironstone from the Woolwich Beds. By the gentle action of solvents, the structure of these bodies is revealed so as to be easily examined by the microscope. They are then found all to agree in possessing a silicified organic structure, which may be described as a network of fibres, or a mass permeated in every direction by anastomosing canals. This structure was subsequently filled in with other material, such as carbonate of lime, silica, bisulphide of iron, phosphate of lime, carbonate of iron, etc., the particular substance thus filled in depending upon the relative abundance of the substances dissolved in the interstitial water of the surrounding matrix. The singular group of concentric siliceous circular bands seen upon many fossils, and known as Orbicular Silica, or Beekite Markings, were also referred to. The fossils on which they occur were imbedded in a matrix more porous than themselves, and of irregular constitution, so that the evaporation, to which the consolidation of the dissolved silica in their pores was mainly due, occurred at a number of points on the surface of the fossil, at which points a deposit of silica took place, forming the central tubercles. The cessation of evaporation was followed by a fresh saturation with the solution, to be again evaporated. But as the evaporating points were now plugged up by the previous deposits, the silica last consolidated was deposited around their margin and upon them internally, appearing outwardly as a ring round the tubercle. Alternations of these conditions account for the numerous bands seen in some of the groups.

CORRESPONDENCE.

THE UPPER INDUS BASIN.

Sir,—Whenever Colonel Greenwood writes on the subject of rain and river action, we are sure to learn a good deal. I am very glad that he has noticed the facts about the Upper Indus alluviums which I laid before the Geological Society, and has entered into the discussion of their causes. With much that he has written I heartily agree; and if on one point I still differ, it is with a mind open to be convinced if the causes I proposed to account for the present state of the alluvial deposits should seem after further argument either inadequate or unnecessary.

I grant the "hard gorge and soft valley" theory of Colonel Greenwood generally; in some instances where I have observed the alternation, a difference in the rocks can be seen to account for it; in others the reason is less clear. Still I am ready to believe that further knowledge of the character and position of the rocks would show that this theory is applicable to most cases.

But I feel great difficulty in agreeing that the accumulation and subsequent denudation of thick alluvial deposits were due only to the variations in slope of the river-bed. In the first place I cannot see how hundreds of feet of alluvial strata could be formed one upon another in a wide valley ending in a gorge, *while the bed of the gorge was sinking from erosion.*

Secondly, we have the alluvial gravels, to a great thickness, *in the gorges as well.* This is evidence that, at the accumulating time, alluvium (of varying degrees of fineness very likely) was deposited all along both valley and gorge; that the river-bed rose everywhere, though not in all places to the same relative height above its rock bottom, nor probably, with one uniform gradient.

There are many instances in the narrow parts of the Indus Valley itself of alluvial pebble-beds two and three hundred feet thick, while in the narrow tributary valleys six and seven hundred feet of them are seen. The cases of Khardong and Tainyār are the two most striking ones that come to my mind at this moment.

This it is that makes me think Colonel Greenwood's theory insufficient. That my own is the right one of course does not follow; and I will not fill up your space at present in maintaining it, being content to attempt advancing the discussion one stage at a time.

28, Jermyn Street,
January 21st, 1874.

Frederic Drew.

THANET CHALK.

Sir,—I omitted to state in my paper on this subject (Geol. Mag. Jan. 1874) that the average diameter of the Ammonites exhibited in the Isle of Thanet is at least three feet: also that any person visiting the section should go at the first or last quarter of the moon, as "the springs" in the Island bring the high tide on between 12 and 1 o'clock in the day, and stop all continuous work between 9 in the morning and 5 in the afternoon.

F. A. Bedwell.

23, Old Square, Lincoln's Inn.
January 17th, 1874.

SCOTCH GRANITE ON WELSH HILLS.

SIR,—Mr. D. C. Davies, F.G.S., is reported to have stated at a meeting of the Geological Society on the 7th of January (after the reading of my paper), that Scotch granite is to be found on the Welsh mountains up to 2000 feet above the sea! Mr. Davies would oblige, not only myself, but, I have no doubt, many of the readers of the GEOLOGICAL MAGAZINE, by mentioning the locality, and whether the granite has been identified by tracing it northwards to its source. D. MACKINTOSH.

ORIGIN OF EARTHQUAKES.

SIR,—I have only just been fortunate enough to see Mr. Malet's interesting paper on the Origin of Earthquakes which appeared in the February number of the GEOLOGICAL MAGAZINE, 1873, Vol. X. p. 74.

I cannot think he has satisfactorily accounted for them, referring them to the action of water percolating underground, wearing away the rocks, and by so doing causing subterranean landslips. Surely if it is to this that Earthquakes owe their origin, they would be found occurring in every country, but far more frequently in those in which is the greatest rainfall. Great Britain and Ireland are probably the most rainy countries in Europe, and accordingly ought to be those most severely shaken by Earthquakes; nevertheless, these are countries nearly entirely exempt from such shocks. No doubt many Earthquakes do occur in England every year, but of so slight a character as to be perceptible only by special instruments for detecting them, and Mr. Malet is evidently referring to those of a more severe character.

On the other hand, when we appeal to that observation of facts on which Mr. Malet lays rightly so much stress, we find a close connexion between the distribution of volcanic areas and the frequency of earthquakes; both volcanos and earthquakes have, in the main, developed themselves in the same directions, and the latter increase in frequency on approaching the focus of volcanic activity.

Again, we hear of earthquakes ceasing when a new volcanic vent has been formed in the district, or an old one re-opened. This is apparently another indication of the community of origin of volcanos and earthquakes, the former acting as a safety-valve to the latter, but by Mr. Malet's theory I can see no explanation of it.

Again, we know that eruptions are attended and preceded by earthquakes, though not of the first magnitude, but instead of considering the eruption the effect of the earthquake, it seems to me more reasonable to assign them both to a common cause, namely. the expansion of subterranean matter causing rendings in the rocks from an over state of tension, and when, as in this instance, occurring at a comparatively slight depth, the melted matter forcing a way to the surface will flow over it as an eruption. The greatest earthquakes frequently take place far from volcanic areas; but we may, I think, with some confidence *refer them to* the same cause producing the *minor shocks; only that taking* place at too great a depth for the melted matter overcoming the resistance of the rocks above to force a passage to the surface; consequently no eruption follows, or in Mr. Malet's words, "an earthquake is an uncompleted effort to establish a volcano." A. Colvin, F.G.S.

New University Club, St. James's Street, S.W.,
December 22nd, 1873.

MISCELLANEOUS.

On the Derivation of the Word "Sarsen."—It was supposed by Dr. Stukeley that the word Sarsen came to us from the Phœnicians, and other writers since his time have adopted it as such; but the greatest authority of the present day confutes the opinion, and states "that no word in the English language is of Phœnician origin." If so, we must inquire what other language will assist us. In the Anglo-Saxon, *ses* is a rock or stone; *sessi*, a settle or seat; *sesan* or *sesen*, rocks. The *e* in *sesan* is without accent, and sounded like *e* in *there*, *ai* in *fair*, or as *après* Fr. The word Sarsen is pronounced by the country people *sāsen*, omitting the *r;* so that, perhaps, the word Sarsen is no other than the Anglo-Saxon *Sesan*, "rocks," and correctly sounded by the Wiltshire descendants of our Saxon forefathers, who still retain many other words of the same origin in great purity; for, as Dean Trench has observed, "they have not gone from us, but we from them." R. F.

Oldest British Starfish.—Mr. Henry Hicks, F.G.S., F.R.C.S., has called my attention to an important omission made in my list of Palæozoic starfishes printed in the last number of this Magazine, page 7. I find I omitted from that list the oldest known British starfish, the *Palasterina Ramseyensis*, a new species, described by Dr. Hicks in the Quart. Journ. Geol. Soc. Lond. 1872, vol. xxix. p. 51, pl. iv. figs. 21–23, from the Tremadoc rocks of Ramsey Island. The specimen was discovered by Mr. Lightbody, of Ludlow. Mr. Hicks mentions that Dr. Otto Torell and Mr. Linnarson had described forms of starfish which had been found in Sweden, in rocks supposed to be of the age of the Harlech group of Great Britain. Another Palæozoic form has also been figured and described by Mr. W. Hellier Baily, F.L.S., F.G.S., in the publications of the Geological Survey of Ireland, to which my attention has been called by Prof. Harkness, F.R.S., of Queen's College, Cork.—H. W.

OBITUARY.

Prof. A. E. Reuss, Vienna.—It is with deep regret we record the death of an able Austrian palæontologist. Prof. Reuss was a Foreign Correspondent of the Geological Society of London, and author of many papers on the Foraminifera, Crustacea, etc. We hope to give a longer notice of Prof. Reuss next month.

THE
GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE II. VOL. I.

No. III.—MARCH, 1874.

ORIGINAL ARTICLES.

I.—The Leinster Coal-field.

By J. McC. Meadows, F.R.G.S.I., Mining Engineer.

HAVING been connected with mining works in this district, the writer offers the following particulars in reference to its seams of Coal, and resources for supply of fuel.

The recent Royal Coal Commission estimated the quantity of Coal in the Leinster Coal-field at 75,000,000 tons. If only two-thirds or 50,000,000 tons be taken as practically available, the quantity is of some importance in connexion with the situation of the field.

Position and general description.

If a short journey by rail be made from the Kildare Junction of the Great Southern and Western Railway to Kilkenny, and from Kilkenny by the Central Ireland Line to Maryborough, and from Maryborough back by rail to Kildare, a complete circuit of the district within which the Coal-field is contained will be made. Surrounded on all sides by lines of railway, and although at some points very nearly approached, the Coal-field is, however, without direct railway communication with any of these lines.

Externally the Coal-district offers a generally uniform character. It consists of a succession of hills, varying from 600 to 1000 feet above the sea-level, which at or near their summits blend one into another, and together form in the interior a tract of undulating country extending over more than 200 square miles. The rivers Dinan and Deehin form the principal drainage lines of the interior, and the fine valleys through which they run in their course to the Nore give a favourable approach from the direction of the City of Kilkenny.

The greatest length from north to south is upwards of twenty miles, and the greatest width about fifteen miles, the northern portion of the field being in the Queen's County, and the southern in the Co. of Kilkenny.

The geological formation consists of alternations of stratified sandstone and shale, forming together, in external shape, an irregularly rounded tract of hill-country, which rests upon the uppermost beds of the Mountain Limestone.

The lower strata of this formation for a vertical thickness of more than 1000 feet appear to be destitute of workable seams of Coal;

and as for the most part these lower beds dip or incline moderately towards the interior, a considerable portion of the formation referred to is met with in the exterior, which is devoid of workable Coal, although interstratified with a few thin seams six inches and under in thickness. For this reason, amongst others, out of the total area of 200 square miles comprised in the district, not much more than one-fourth represents in the interior the Coal-field proper, or that portion of the formation within which the lowest workable seams of Coal have been found.

The strata in general undulate, and on all sides finally dip or incline to one common centre. This centre is in appearance basin-shaped, and it forms the main Coal-basin of the Lordship of Castlecomer and Doonane, with the detached basins of Clough and Newtown.

In this paper these Coal-basins will first be referred to, and afterwards the seams of Coal in the exterior of the field.

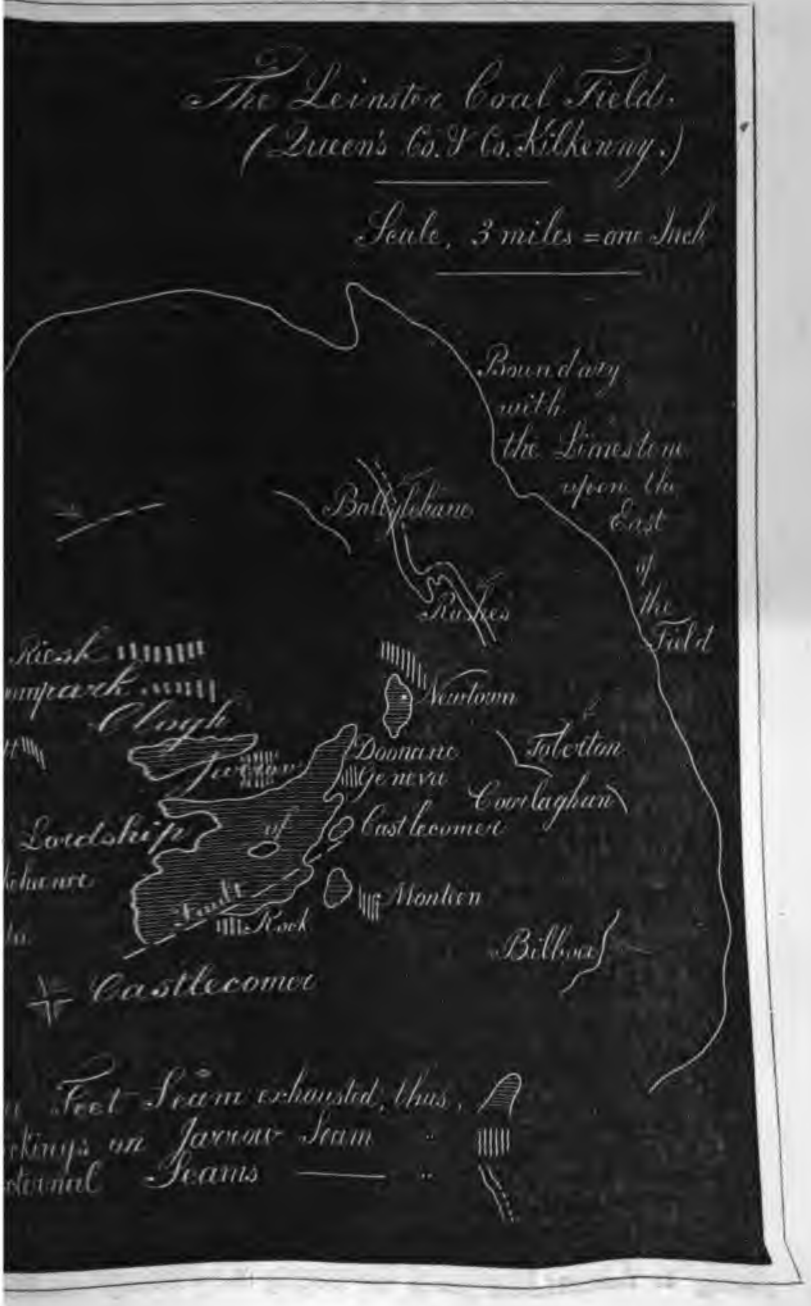
Interior of the Coal-field.

In these central basins once lay the celebrated "Kilkenny Coal." An exceedingly pure anthracite Coal, it varied from two feet six inches to three feet four inches in thickness, and is known as the three-feet seam.

Commencing at little more than a mile north-east of the town of Castlecomer in the Co. of Kilkenny, this seam of Coal extended into Doonane in the Queen's County, a distance of about four miles. Narrow at both ends and irregular in shape, the main central basin of the Lordship of Castlecomer had, however, from east to west, a maximum width of more than a mile and a half, and the entire area was favourably circumstanced for working, as the seam lay at comparatively shallow depths below the surface. The pits or shafts seldom exceeded sixty yards in depth, while the majority ranged from twenty to forty yards each.

With the exception of the northern end at Doonane, this central basin forms part of the Lordship of Castlecomer; and it may be said that the system of working by a number of small pits which was adopted more than 150 years ago, on the opening out of the seam by the then Sir Chr. Wandesforde, continued to be followed until its exhaustion within the last 25 years. During that period this seam of Coal was generally worked by the successive proprietors of the estate upon a system of contract with tenants and others, under one general engineering superintendence and management.

In addition to this principal basin, there lay two smaller basins of the same seam of three-feet Coal immediately near it. One was the Clough Colliery on the west, and the other that of the Newtown Colliery on the north. At one time, all formed a single basin; but owing to undulations of the strata and subsequent denudation, these smaller basins are now found detached. With the exception of some portions of the seam which were left in the Clough Colliery, owing to insufficient power for keeping the workings unwatered,


The Leinster Coal Field.
(Queen's Co. & Co. Kilkenny.)
Scale, 3 miles = one Inch
Boundary with the Limestone upon the East of the Field
Ballylehane
Rushes
Riesk
mpark
Clogh
Jarrow
Newtown
Doonane
Geneva
Castlecomer
Toberton
Coolaghan
Lordship of
ehane
la.
Fault
Rock
Monteen
Bilboa
Castlecomer
Feet Seam exhausted, thus,
kings on Jarrow Seam
itional Seams

the three-feet seam has been for several years past also exhausted in these two basins.

The total quantity of Coal obtained from this seam of Coal may be estimated at about 14,000,000 tons.

That source of supply having been exhausted, inquiry will next be directed to the other resources of the field.

About the year 1810, and subsequently, the existence of a seam of Coal below the three-feet seam was ascertained by borings made under the direction of the late David Aher, C.E., then manager of the mines of the Lordship of Castlecomer, in portions of the Coal-field that lay between the principal basin of the three-feet seam on the east and the Clough Colliery on the west, in ground into which the three-feet seam did not extend. Upon the site of one of these borings, on the lands of Cloneen, a shaft was sunk about the year 1829, under the direction of the late Matthias Dunn, and was called Jarrow, after the Jarrow Colliery in the North of England.

In this shaft, at a distance of about sixty yards from the surface, a seam of anthracite Coal was found, in appearance and structure widely different from the three-feet seam. When in its best condition, it has a thickness of about four feet, and it is called the Jarrow or four-feet seam. Of this thickness of four feet, however, usually more than one-half consists of inferior Coal, the remainder being clean hard Coal of excellent quality.

It is irregularly massive in shape, sharp at the edges in fracture, and somewhat uneven or granular on the surface. Slow to kindle, but once fully ignited, it gives out much heat, and lasts for a considerable time, sometimes for hours together, without requiring attention or renewal.

While the three-feet seam of Coal could be had, the working of the Jarrow seam was not carried on with vigour; but of late years considerable quantities of this Coal have been raised, and this seam is now reputed to be the most important and valuable in the district.

About the year 1861 the further working of the first or No. 1 Jarrow Pit was discontinued, and a second shaft called the No. 2 Pit, about seventy yards in depth, was sunk more to the dip of the seam. Subsequently the original shaft was re-opened, and Coal is now raised from both.

In addition to these workings, the sinking of a third or No. 3 Jarrow shaft upon the same seam is at present in progress.

From the workings that have been made, this Jarrow seam is found to be variable in its thickness. In its bed it lies in easy undulations of the strata, and in the interior of the field it has its greatest development of four feet in thickness, principally in the deepest portions of these undulations.

When, however, it rolls over or rises towards the surface with the gradual ascent of the strata, it has been found generally to decrease in thickness, and sometimes to thin out to one-half or less than that in thickness.

From borings that have been, from time to time, made upon the royalties of the Lordship of Castlecomer, in addition to the workings already mentioned, its extension and continuation under the whole area that was once underlaid by the three-feet seam, may be said to be now well established. The Jarrow seam is, in fact, the first workable bed of Coal which is met with below that seam.

Some of the borings that have proved this seam were made through pits in which the three-feet Coal had been worked. The thickness of strata between both seams may vary from seventy to eighty yards.

When it is borne in mind that there has not been as yet any working upon the Jarrow seam at any point under the three-feet seam, and that such workings as have been made upon it are all of them outside of the croppings or outgoings of that seam, it becomes evident that the Jarrow seam is likely to prove a principal source of supply of Coal in the future working of the field.

When circumstances shall call for a large development of its coal resources, the first step for that purpose will be taken when sinkings shall be made to the Jarrow seam through some of the deep portions of the principal basin of the three-feet seam.

In addition to the workings already referred to, the Jarrow Coal was, for some time, worked at Massford, and it is at present worked at The Rock Colliery, both near Castlecomer. More than eighty years ago its outgoing was discovered eastward of the Doonane portion of the three-feet seam, and some workings were then made upon it, and within the last twelve years at the Geneva Colliery, near Crettyard.

Its extension into Clough, the estate of George Leopold Bryan, Esq., M.P., was ascertained by the position and lie of the seam in the No. 2 Jarrow Pit, and works are in progress, and a shaft is now being sunk to that seam upon the Clough royalty.

At Monteen, upon the eastern side of the field, workings have been for some time and are at present carried on upon the Jarrow seam; but here it has been found upon the average to be not much more than from two feet to two feet four inches in thickness.

At the Hollypark Colliery, in the Queen's county, it has also been worked upon its northern verge or outgoing, outside of the outcrop of the three-feet seam of the Newtown basin. These works are in operation at present; but in this instance that Coal, as far as it has been as yet wrought, belongs to the class of a thin seam.

Upon the west, the Jarrow seam has been partially worked upon its verge or outcrop at the Broompark and Riesk Collieries, with a thickness of about eighteen inches; but whether in the condition of a thick or a thin seam, it generally retains the character of a strong useful coal. It may be worth remark, that wherever this seam has been found to approach the surface, its condition has been that of a thin seam of Coal, usually of workable thickness.

Lower Seams and Exterior of the Coal-field.

To ascertain what workable seams of Coal lie below the Jarrow seam, a useful point for observation will be found anywhere at the Newtown basin of the three-feet seam. There in its best condition a tract of that seam once lay, and if a line of section be now taken to the north of the Rushes School-house—a prominent feature at this part of the field—the structure of the district generally will present itself. Advancing forwards from the Newtown basin, the Hollypark Colliery is met, in which the underlying Jarrow seam has been partially worked along its verge or outcrop, as already mentioned, although in the condition of a thin seam only; and passing from it, at a distance of less than one mile, the Rushes Colliery is next met with, in which the Rushes seam of Coal, about eighteen inches in thickness, was worked several years ago.

This Rushes seam is the principal Coal-seam of the exterior of the field. At Clogrennan Hill (Bilboa), upon the east, at Ballylehane or Modubeagh, and Mullaghmore upon the north, and at Skehana and Firoda upon the west and south, this seam has been partially worked, and these workings may be taken as its principal landmarks. Around the district it varies from fourteen inches to two feet in thickness, and it may be called, upon an average, an eighteen or twenty-inch seam. It is softer than the hard Coal of the interior, and the seam sometimes consists in part of fine Coal or Culm, with thin bands of clean Coal. It is quicker in kindling, but does not make so lasting a fire as the hard Coal. The only mining works that have been of late undertaken in the exterior of the field are those at Ballylehane or Modubeagh, where a shaft is being sunk to reach a portion of this seam at the north of the district.

Although met with and partially worked at several points, it is not meant to be conveyed that this Rushes seam is unbroken or completely continuous in the exterior, from one point to another. Owing to denudation, faults, and dislocations of strata, its continuity may be frequently interrupted, and from the same causes it may be, in some places, altogether wanting.

Whatever its condition may be, it will, however, be found to underlie and to extend under the seams of Coal that have been already described in the interior of the field.

To complete the examination of the seams of the exterior, it remains to be mentioned that at a depth of about 60 yards below the Rushes seam of Coal, another is found which has been called the Rossmore Foot Coal, varying from ten to twelve inches in thickness. If the line of section be continued from the outcrop of the Rushes seam, the outgoing of this last-mentioned or Rossmore seam may be observed.

As at a few points Culm has been raised from this latter seam, although in very inconsiderable quantity, it may be considered, as far as present evidences extend, the lowest seam with any pretensions to be classed as workable in the Leinster Coal-district. The workings that have been made upon the Rushes seam and upon the Rossmore Foot Coal mark in part the principal points of the circumscribing line, within which the Coal-field proper is contained.

Before a complete section of all the workable seams can be given, [redacted] part of the field known as the Hill of Coolbane has to be ed. It forms, in the interior, the steep hill or ridge upon the side of the high road between Castlecomer and Crettyard, a special feature of the Coal-field.

The three-feet seam of Coal extended here to the foot of the hill, and there, by a fault or dislocation of the strata which runs somewhat parallel with the hill, the seam was thrown down to a lower level. Owing in part to being so thrown down, but mainly to the steepness of the hill-side, which here rises quickly and immediately over it, there is here found overlying the three-feet seam a greater vertical thickness of strata than has been met with over that seam at any other part of the field. These strata contain in them three other workable seams of Coal that are nowhere else found together in the field, but which obviously once extended over the entire area of the three-feet seam, before the land had been worn away and shaped as it is now found.

These upper strata extend, however, but for a short distance. Immediately to the east of them, and nearly parallel with the crest of the hill, one of the principal faults of the Coal-field strikes away in a north-east and south-west direction, bringing up to the south-east, within a few feet of the surface, the strata that contain the three-feet seam of Coal, and with them an extension of that seam upon the hill and the high ground behind it to the east and north, in the direction of Monteen and the Doonane river. The maximum displacement or throw of this fault is about eighty yards.

In the strata that have been referred to as forming the hill-side to the west of this main upthrow fault, in a thickness of less than seventy yards over the three-feet seam of Coal, the following section is found:—

	STRATA.		COAL.	
	Yds.	Ft.	Ft.	In.
Surface-soil and sub-strata	4	0		
Peacock, or 22-inch seam of Coal			1	10
Intermediate strata	15	0		
Stony Coal			3	0
Intermediate strata	7	0		
Double seam			2	6
Intermediate strata	36	0		
The three-feet seam			3	0

To these may now be added the other seams and strata, in descending order, viz.:—

Intermediate strata, between the three-feet seam and Jarrow Coal, from 70 to 80 yards	70	0		
Jarrow Coal, from one foot to four feet in thickness, average			2	6
Intermediate strata, thickness not ascertained, but it may be from 150 to 200 yards	unascertained			
Rushes seam			1	6
Intermediate strata	60	0		
Rossmore Foot Coal			1	0

As far as present knowledge of the field extends, the foregoing section presents a fair classification of the several workable seams of the Leinster Coal-district. Seams six inches in thickness and under are omitted, as, although useful to the miner for the identification of particular beds, they are not of any commercial value.

Surveys of the District.

In the year 1814 a Geological and Mining Report upon the Leinster Coal-district, by Sir Richard Griffith, then Mining Engineer to the Dublin Society, was published by that Society. This Report was accompanied by an engraved map and sections, and after a lapse of more than sixty years since the survey was undertaken, the work done and the results arrived at form an enduring testimony to the abilities of Griffith, and to an earnestness of purpose that makes his labours upon that survey at such an early date a model of work for others. The main features of the structure of the field as described by Griffith have been followed in this paper, and the writer believes that they recommend themselves, upon their own evidences, to all who have had any practical mining knowledge of the district.

In the year 1859 the results of an examination of the Coal-field by the Geological Survey of Ireland were given to the public in the Geological Map-sheets of that part of Ireland, with sheets of sections and two descriptive pamphlets. The classification of the seams by that Survey is not in harmony with the results arrived at by Griffith.

For the general structure of the field, as given by him, and summarized in this paper, there is substituted a theory that the external workable seams do not underlie the seams of the interior, but that they re-appear, and that the seam which was worked at the Rushes and Clogrennan Hill formed in the interior of the field the three-feet seam of Coal. There are difficulties in the way of an acquiescence in this theory,—and they are not lessened when it is found that the Coals worked at the Geneva, Monteen, Riesk, and Moyhora Collieries are also classed by that Survey as belonging to the three-feet seam.

In contrast with the conclusions arrived at by the Geological Survey, it is only necessary to refer to a comparison of sections of strata over the Rushes seam and the three-feet seam, to show that such conclusions are open to re-consideration.

At Tilly's Pit on Ballylehane, upon the Rushes seam, there is a sectional thickness of strata in the shaft of more than 90 yards, with only one intermediate thin unworkable seam of Coal in that section overlying the Rushes seam.

In the side of the Hill of Coolbane, however, there are found over the three-feet seam, in a sectional thickness of less than 70 yards of strata, three distinct intermediate workable seams of Coal.

These sections appear to be so deficient in elements of constructive identification, it is thought unnecessary to refer to the differences which are found in the strata themselves, or in the thicknesses and qualities of the seams of Coal.

In connexion with the structure of the field as presented in this paper, reference may be made to the Slievardagh Collieries.

From the Leinster district the underlying limestone and the lower beds of the Coal-formation extend in a south-westerly direction into the Co. of Tipperary, and the formation is found to preserve its upper or Coal-bearing strata as it approaches the town of Killenaule. In the hills to the north of that town are the Slievardagh Collieries, and as the lower beds and the underlying limestone are continuous [illegible] one district to the other, some approximate similarity in the relative positions and characters of the seams of both districts may be looked for.

The Slievardagh field has the advantage of regularity in its stratification, and the following is a section of the deepest portion of the field near its centre, at the Earlshill Colliery:—[1]

	Strata.		Coal.	
	Yds.	Ft.	Ft.	In.
Surface and uppermost beds	20	0		
Partenclea, or four-feet seam			4	0
Intermediate strata	37	0		
Clashacona Coal			2	0
Intermediate strata	10	0		
Healey's Vein			1	6
Intermediate strata	30	0		
Crow Coal			2	0
Intermediate strata	47	0		
Main Coal			2	0
Intermediate strata	67	0		
Maher's Vein			0	8
Intermediate strata	170	0		
Second, or Upper Glengoole seam			1	8
Intermediate strata	43	0		
First, or Lower Glengoole seam, being the lowest workable seam in the Slievardagh district, varying from one foot to one foot six inches in thickness			1	3

As in this section there is an upper seam for which in the Leinster field there is a deficiency of strata over the Peacock Coal, the sections of the two districts will be best contrasted in ascending order from the lowest workable seam in each.

It is submitted that the No. 1 and No. 2 Glengoole seams of Slievardagh represent the Rossmore Foot Coal and the Rushes seam of Leinster, and that Maher's Vein and the Main Coal of Earlshill represent the Jarrow seam and the three-feet seam of the Castlecomer field. The thickness of strata between the No. 2 Glengoole seam and Maher's Vein points to the distance, which is also felt to be considerable, between the Rushes seam and the Jarrow Coal.

When the sections are examined in detail, and the relative qualities of the seams compared by those with practical knowledge of both districts, other parallels, unnecessary here to refer to, will be observed. Amongst them, however, may be mentioned as common to both districts the character of the coal of the two lower workable seams in which Culm or fine coal occurs, and the preponderance of hard coal in the upper seams.[2]

Present Condition.

Upon a recent visit by the writer, the several mining works, at present raising coal in the district, were found to be as follows:

Upon portions of the upper seams,—Pits on the Hill of Coolbane.

Upon the Jarrow seam,—Jarrow Pits Nos. 1 and 2, the Rock Colliery, Monteen Colliery, Hollypark Pits.

Upon the lower seams,—Skehana Colliery, Ballylehane, Tolerton, Rossmore, and Reevanagh.

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[1] Geol. Survey of Slievardagh Coal-district, Sheet 146, and accompanying Memoir.

[2] It may be mentioned that a further examination of the Leinster Coal-field is now (1874) in progress by the *Geological Survey of* Ireland.

In addition to the foregoing, some few pits are occasionally met with upon shallow portions of basins of the three-feet seam, for recovery of remnants of Coal that may have escaped the efforts of former searchers.

The present output of the Coal-field is at the rate of about 80,000 tons yearly. Of this quantity about one-half consists of small Coal and Culm, which are used for the burning of lime and bricks, and as fuel by the poorer classes. Sixty years ago, when Griffith made his Report, the output was estimated at about 170,000 tons yearly.

Character of the Coal.

All the seams are of the Anthracite class and entirely smokeless. The three-feet seam was a very pure coal, and in its composition almost entirely free from the pyritic or sulphurous intermixtures with which the other seams are more or less impregnated.

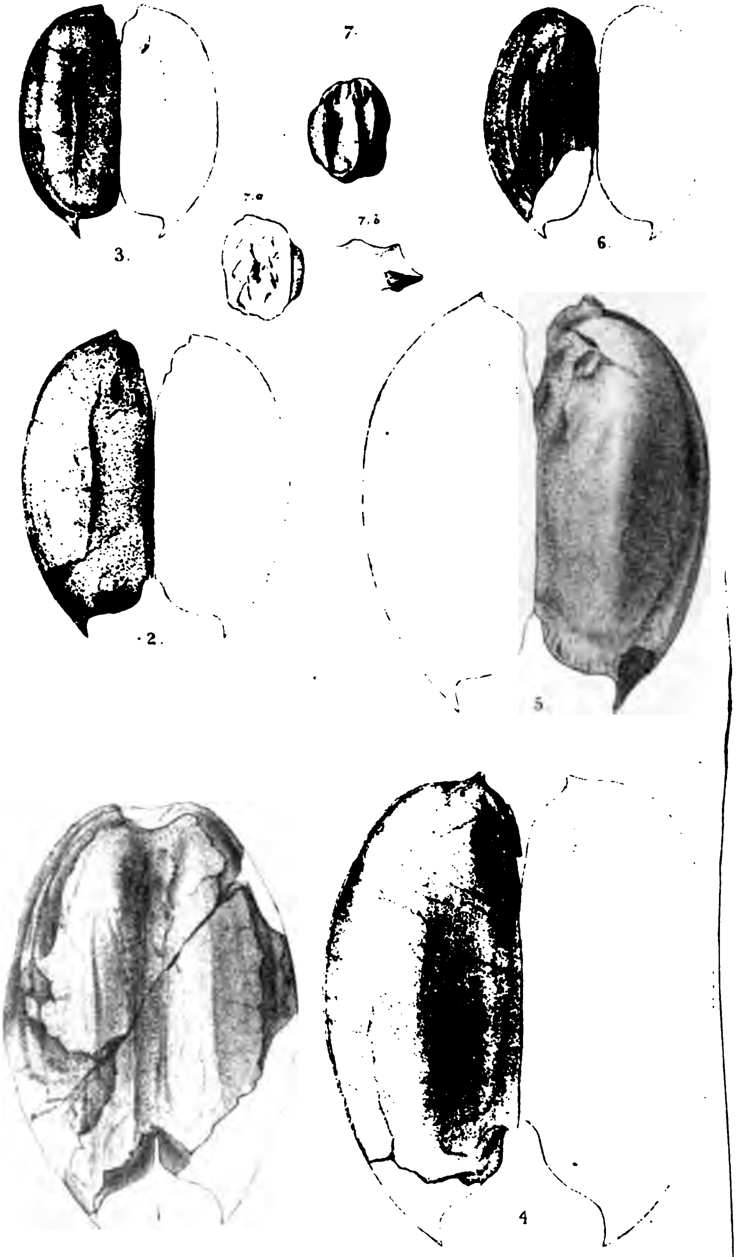
To persons not familiar with the use of these descriptions of Irish Anthracite coal, the gases given off in burning are disagreeable where there is not sufficient chimney draught for their removal, and for this reason, amongst others, the use of the coal for house purposes has not extended much beyond the belt of country in which, around the Coal-district, it has become long and well established as the local fuel. With those that have been accustomed to it, the disadvantage referred to weighs, however, but little when the high heating power and lasting properties of the coal are taken into account. For the drying of corn and of malt there is a good external demand for this coal, and as for these purposes the best and hardest portions are always selected, it adds to its other qualities capability of transport to long distances without much waste or loss.

The Mining Population.

About 600 persons, including men and boys, are at present employed underground in the several mining works. Of this number 270 are colliers, whose special work is the getting of the coal from its bed, and about 240 constitute the miscellaneous mining labour employed underground in bringing the coal to the bottom of the pits or shafts, and keeping the working places and roadways or levels of the mines in working condition. About 70 are able miners who are employed in the sinking of the shafts at present in progress in the district.

Speaking from experience, and taking into account the labours they undergo, the miners, as a class, are an intelligent and well-disposed body of men. Owing to the nature of their work, they do not, however, in general, enjoy the robust health of the mechanic or field labourer, and much yet remains to be done for their better well-being in life.

It is much to be desired that with the progress which now brings material comforts to most classes, improved dwellings may in future replace the almost comfortless abodes that are now pointed out to the stranger as the miners' homes, and which for the most part give but doubtful shelter to families and men upon whom not only the *district itself, but* a large extent of country around it, is mainly de-



[illegible] Mintern Bros imp.

Four new Species of Dithyrocaris
from Lanarkshire

pendent for convenient supply of fuel. In bringing the present paper to a close, the writer feels that he would but inadequately perform his task if he confined himself to the discussion of seams of coal, without reference to the men by whose labour they are made available, or without expressing a hope that with increased industrial enterprise, there may be henceforth coupled in this district a reasonable solicitude for the material comfort of the working miner.

In conclusion, the writer offers his best thanks to the several mining proprietors for aiding him in his inquiries, and enabling him to give, with accuracy, the condition of the field as regards its present output of coal.

II.—ON SOME SPECIMENS OF *DITHYROCARIS* FROM THE CARBONIFEROUS LIMESTONE SERIES, EAST KILBRIDE, AND FROM THE OLD RED SANDSTONE OF LANARKSHIRE.

By HENRY WOODWARD, F.R.S., F.G.S., etc.,
of the British Museum, and
ROBERT ETHERIDGE, Jun., F.G.S., etc.,
of the Geological Survey of Scotland.

(PLATE V.)

(*Continued from November*, 1873, p. 486.)

3. *DITHYROCARIS OVALIS*, W. and E. (Pl. V. Fig. 1), Mems. Geol. Survey, Expl. Sheet 23, Scotland, 1873, p. 100.

This species most nearly resembles *D. Colei*[1] in outline, but is little more than half its size, and is quite destitute of the strong median and lateral ridges which mark Portlock's species.

The specimen is from East Kilbride, and was obtained by Mr. A. Paton; it has both the valves united, although somewhat fractured and imperfect.

Its general outline is oval; its length as contrasted with its breadth being as three to two.

The anterior ends of the conjoined valves are roundly produced, inclosing a slight mesial indentation in front.

The posterior border of the shield is more deeply indented in the centre, and the lateral margins are produced and terminate in an acute spine on each side.

The greatest length of the shield, measured along the latero-mesial line, to the tip of the posterior spine, is 55 mm.; its length along the dorsal line is 45 mm. Its greatest breadth across both valves is 38 mm.

The surface of the carapace is nearly smooth, save at the anterior extremity and close to each side of the mesial line, where it is finely granulated; the maxillary ridges are situated about 4 mm. on either side of the mesial line, which is not very strongly marked; the two lateral ridges running parallel to the mesial ridge are only faintly indicated.

The margins of the shield are decorticated, but the impression of the double border is clearly seen upon the matrix.

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[1] See Geological *Report on Londonderry*, etc., by Captain Portlock, Dublin, 1843, *p. 314, pl. xii.*

The front border appears to have been roundly produced on each side with a shallow median indentation; the posterior border was [illegible] furnished with two lateral spines, having the usual mesial [illegible] between them.

The surface of the carapace is plain; the maxillary ridges are not seen.

Locality and Formation.—In greenish-grey shale of the Lower Old Red Sandstone, Carmichael Burn, S.E. of Lanark, associated with *Orthoceras dimidiatum*, Sow., etc. Collected by Mr. A. Macconochie. In the Collection of the Geological Survey of Scotland.

Position of the beds from which the foregoing species were obtained.

The preceding five[1] Carboniferous species of *Dithyrocaris* were all obtained from the shale overlying the Calderwood Cement Stone of the East Kilbride district, Lanarkshire.

The Calderwood Cement Stone is worked at Calderside and East Kilbride, where it attains an average thickness of about ten inches. According to Mr. James Geikie, District Surveyor of the Geological Survey of Scotland, it is the equivalent of the calmy limestone overlying the First Kingshaw Limestone of the Lower Carboniferous Limestone Group of the Carluke District. The Cement Stone near East Kilbride is succeeded in a descending order by three limestones, locally known as the No. III., II., and I. Calderwood Limestones, with their intervening and accompanying shales, certain of which have proved very fossiliferous, especially that between the two lowest, or Nos. I. and II. Limestones of the section. From this band of shale, at the foregoing and other localities of the district, many of the rarer Carboniferous fossils, in addition to those of more common occurrence, have been obtained both by the collector of the Geological Survey, Mr. J. Bennie, and by local collectors, especially Mr. A. Paton, of East Kilbride. Amongst these fossils may be mentioned six species of *Foraminifera*, which were kindly determined for the Survey by Mr. H. B. Brady; they are, *Endothyra ammonoides*, Brady, MS.; *E. Bowmanni*, Phil.; *E. globolus*, Eichw.; *Trochammina incerta*, D'Orb.; *Valvulina plicata*, Brady, MS.; and *Webbina acervalis*, Brady, MS.; both species of Prof. Duncan's genus *Palæocoryne*, *P. Scoticum*, and *P. radiatum;* amongst *Annelida*, *Spirorbis caperatus*, McCoy, and *Ortonia carbonaria*, J. Young; many *Entomostraca* and *Polyzoa*, including De Koninck's recently described *Archæopora nexilis*, with many *Brachiopoda*, and other Mollusca.

The sixth species here described, *D. ? striata* was obtained from the Lower Old Red Sandstone at Carmichael Burn, near the Manse, about 4½ miles south-east of Lanark, in greenish-grey flaggy shale, by Mr. A. Macconochie, Geological Survey Collector. (Vide *Sheet and Explanation*, 23, *Geological Survey, Scotland*, 1873, pp. 14, 57, and 100.)

[illegible] of the species of *Dithyrocaris* were described in the First Part of this Paper, [illegible] Mag. 1873, Vol. X. p. 482, Pl. XVI.

EXPLANATION OF PLATE V.

FIG. 1.—*Dithyrocaris ovalis*, W. and E., specimen having both valves preserved united along the mesial line.

FIG. 2.—*Dithyrocaris granulata*, W. and E., the left half of the carapace only preserved.

FIG. 3. ———— ———— ditto.

FIG. 4. ———— *glabra*, W. and E., the left half of the carapace only preserved.

FIG. 5. ———— ———— W. and E., the right half of the carapace only preserved.

FIGS. 1–5 were all obtained from the Black Carboniferous shales overlying the Calderwood cement-stone, E. Kilbride, Lanarkshire.

FIG. 6.—*Dithyrocaris? striata*, W. and E., part of the left valve only preserved. Lower Old Red Sandstone, Carmichael Burn, S.E. of Lanark.

FIG. 7.—The small specimen of *Dithyrocaris tricornis*, Scouler, referred to in the former part of this paper, see GEOL. MAG. 1873, Vol. X. p. 485, as showing "the same infolding of the lateral margins as the larger example displays." (See Vol. X. Pl. XVI. Figs. 2 and 3.)

III.—GLACIALOID OR RE-ARRANGED GLACIAL DRIFT.

By G. H. KINAHAN, M.R.I.A.

IN many places in Ireland, but conspicuous in the S.E. portion, there is a Glacialoid drift (that is, a drift very similar in aspect to some of the typical Glacial drift). This drift will be found in places above the shelly drifts of Wicklow and Wexford, and has led Prof. Harkness, F.R.S., to believe that in those counties there is evidence for two distinct periods of glacial drifts, one below and the other above the shelly drift. His classification has been adopted by Mr. A. Bell[1] and others; still there does not appear to be evidence in Ireland for two distinct ages of glacial drift, separated by an interval, represented by sub-aqueous accumulations (sand, gravel, marl-clay, &c.), and the reasons for this conclusion will be given in this paper.

There is reason for supposing that in Ireland since the great Glacial period there have been four marked changes in the level of the country:—

I.—During the first, the land sank from 250 to 350 feet lower than at present. This we will call the *Period of the* 300 *feet sea beach* or the *Esker sea period.*

II.—At the second the land was stationary for some time, while between 70 and 120 feet lower than it now is. This may be called the *Time of the* 100 *feet sea beach.*

III.—At the third there was a rest when the land was from 20 to 30 feet lower than now. This I propose to call the *Time of the* 25 *feet sea beach.*

IV.—At the fourth the land was at least 30 feet higher than it is now. The subsequent depression by which it was brought to its present level appears to be still in progress in certain places.

These changes seem to have been more or less prevalent over the whole country, but not always uniform, as since the Glacial period the drifts have been affected by faults, some of very recent date, and on their downthrow sides the drift may be much lower than on the upthrow, on which account the ancient sea beaches are not universally at the same elevation.

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[1] Palæontology of the *Post-Glacial Drift* of Ireland, by Alfred Bell, GEOL. MAG. *1873, Vol. X. p. 447.*

I.—The evidence for this movement is very general throughout the island, as in many places below the 350 feet contour line, and in all places below the 250 feet contour line, the Glacial drift, whether Boulder-clay drift or Moraine drift,[1] is more or less washed and sorted into silt, sand, gravel, or shingle.

II.—This interval of rest at the level specified seems proved by the raised beaches in places near the coast, and in valleys between 70 and 120 feet above the level of the sea.

III.—That the land was stationary at this stage is proved by raised beaches and old sea cliffs found at or near the present coast line; while the subsidence

IV. is evident from the sub-marine bogs off the coast and the submerged bogs and land accumulations under the muds, etc., in the estuaries, lagoons, salt-marshes, and elsewhere.

The accumulations formed during the time included in Nos. I., II., and III. are very similar in aspect, and may be clays, marls, sands, gravels, or shingles. It does not appear improbable that if properly worked out they might be found to contain different suites of fossils; this, however, has not as yet been done, and the fossils collected from the different zones have all been grouped together. All the shelly drifts on the east and south-east of Ireland, with the gravels containing chalk flints on the coast of Cork, have been classed as one, by Prof. Harkness, while it is quite evident that portions of them, at the east and south-east are distinct, and belong to the three different periods, while all the Cork gravels containing chalk flints probably belong to the second or third period, as high up above them in the hills are the remains of the 300 *feet sea beach.*

The gravels mentioned by Mr. Du Noyer on the coast of Dublin and Louth belong to the second or third period, probably the latter, while those near Howth Harbour seem to belong to the second.

In the south-east portion of Wicklow, and in the co. Wexford, the marls, sands, gravels, and shingles of the time of the 100 feet beach in general contain fragments of shells; but as these drifts are made up of the re-arranged older shelly deposits, much cannot be learned from them, unless it shall be proved hereafter that they contain fossils which do not occur in the shelly drifts of the first period.

In the central plain of Ireland the gravels of the "Esker sea period," as a rule, are devoid of fossils. These have, however, been found in a few places, as Dr. Oldham, F.R.S., records them at Finglas, co. Dublin (200 feet); Clane, co. Kildare; Naas, co. Kildare (380 feet); between Athy and Castle Comer on the slopes of the high Coal-measure table land; and at Roscrea, co. Tipperary (400 feet). Sir R. Griffith has recorded fossils in the drift at Tarmon Hill, co. Mayo (250 feet); and the late General Portlock found them in the co. Sligo at 200 feet, and in the co. Londonderry up to 300 feet. I found one shell in the Esker at Maryboro', Queen's co.; while Messrs. Bryce and Hyndman have found them near Belfast up to a height of 150 feet. All these localities, except, perhaps, those of Messrs. Bryce and Hyndman, are probably in gravel or sands belonging to the "Esker sea period," and the great height at which some of them are found will be hereafter referred to. From the above it is seen that although as a general rule the "Esker sea period" gravels are without fossils, yet in some places these do occur; and this peculiarity may be due to the conditions under which the drift was formed. As in places these gravels contain fossils, and as they occur at an elevation very similar to that of the shelly drifts of the co. Wexford, it does not appear unreasonable to suppose that all were formed simultaneously; and in support of this idea it should be mentioned that to the south-west, and north-west, the Wexford shelly drift seems to graduate into unfossiliferous accumulations, while in both localities they seem to merge into the "Esker sea period" gravels: from the first, through the valleys of the Suir, the Nore, and the Barrow; and from the latter, through the valley of the Slaney: while in places, both on the Esker gravels of the central plain, and on the Wexford shelly drift, there are perched erratics that seem to have been dropped from icebergs. If this suggestion is correct, the drifts of Wexford and south-east Wicklow must have accumulated under conditions more favourable than the other "Esker sea period" gravels to the growth and preservation of the shells now found in them.[1]

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[1] *Moraine drift*, called Boulder drift in my early papers on the Irish drifts.

It was at one time suggested that the ridges or eskers of the central plain of Ireland were the remains of a central gravelly member of the glacial drift, and that it had once been covered by a newer Boulder-clay. If such had been the case, it is scarcely possible but that in that portion of the island a part of the Upper Boulder-clay would have remained, to record its former existence. This suggestion, however, had to be abandoned, as the Officers of the Geological Survey in no place could find the remains of this Upper Boulder-clay, but, on the contrary, found that the "Esker sea period" gravels were always the highest member, whether the subjacent drift be the older Boulder-clay drift or the newer Moraine drift, the Esker-gravels stretching continuously over both. In the S.E. of Ireland, in the counties Wicklow and Wexford, over the shelly drifts is found in places a drift that sometimes contains ice-dressed blocks and fragments, and in places graduates into true glacial-drift.[2] This *Glacialoid* (or glacial-like) drift, however, also graduates into, and is interstratified with, the shelly gravels, marls, and clays, and does not always contain the ice-dressed blocks and

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[1] Sir H. James records shells at a height of 400 feet on the Forth Mountains, co. Wexford. There would, however, seem to be a mistake in the figures, as Mr. Wyley, during his survey, did not observe them, but states they are not to be found above 250 or 300 feet, and the drift on the higher portions of those hills is a rock detritus in which shells could scarcely occur.

[2] On the borders of the counties Limerick and Tipperary, fringing the high land [Slieve Phelim], Glacialoid drift is found capping and interstratified with the Esker-period gravels.

[illegible], but it may have been due to a sudden change in the lev of the land, or, what seems more probable, to the formation of sar banks that dammed up portions of the slobs, causing the water c them suddenly to become brackish or even fresh.

These sunken and submarine bogs are as yet unexplored, coı sequently their depth beneath the level of the sea is unknown. Pea however, from 10 to 16 feet deep, has been sounded in places off tl south and west coast, below low water of spring tides; while during tl works carried on for the reclamation of the estuary muds of Wexfoı Harbour, peat about 5 feet thick was found under 16 feet of the mu the lowest portion being 21 feet below the surface; and these mud before they were reclaimed, were covered at half-tide. It may al be mentioned that in places off the mouth of Wexford Harbour the are now tidal islands in places, which in the ancient charts weı marked as "dangerous shoals."

A *résumé* has now been given of the movements that are know to have changed the level of the country, and a short description the drifts and other deposits accumulated during these recent periods we may therefore return to the *Glacialoid drift;* and as we believe is not a true glacial drift, we will give suggestions as to how it ma have been formed, illustrating these by facts that can be observed the present day.

The *Glacialoid drift* of south-east Ireland occurs over or interstrat fied with shelly drifts, while under the latter are typical glaci drifts. Beginning to the northward at Killiney-hill, co. Dubli there is a shelly gravel overlying a Boulder-clay. The latter drift c be traced southward from that hill along the sea-cliff to Bray rive it appearing at the base of the cliff under the shelly drifts. It nearly continuous all the way; but as the drifts have been moved and down by recent faults, in a few places, where it has been l down below the sea-level, it is hidden from view. Over this Boulde clay the drift may be sand, gravel, in a few places a shingle, or ma or clay, often a good brick clay; and all except the last are mc or less shelly. There is also a sandy clayey accumulation, which places contains subangular or rounded blocks and fragments, some which are partially ice-dressed. The latter variety only occurs in ve subordinate quantities, and always graduates into the gravels or clay generally the latter. The division between the shelly drift and t Boulder-clay is in general well marked, and the change from one another abrupt; but in a few places it is not so, one being a litt southward of Shanganagh river, where near the base of the form there is a thin subordinate bed of Boulder-clay. Inland, in the count between Kingstown and Bray, similar varieties of the upper drift occı with apparently the same relations to one another; while where t Boulder-clay drift is exposed, they always appear to lie on it.[2]

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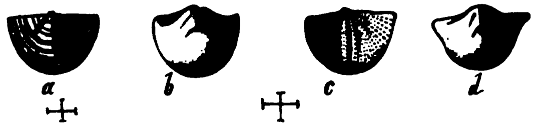
[1] The Æolian drift or blowing sand has not been mentioned in connexion w these accumulations, as such sands may be of any age, some being as old as the la part of the *Glacial Period*, having been formed while the moraine drift was accum [illegible]ting, while portions are forming at the present day.

[2] There is a section exposed in the old sea-cliff at Dunleary Harbour, east of -*hill Hotel, in which*, as seen from the railway, a Boulder-clay-like drift overl

10



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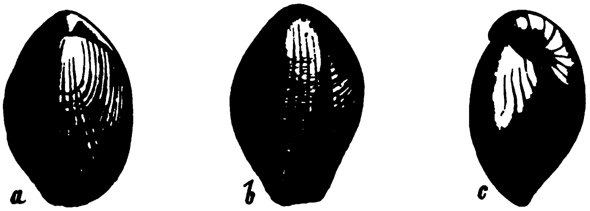

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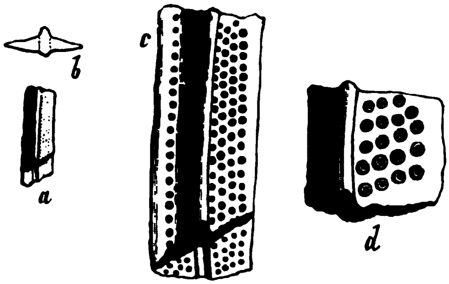

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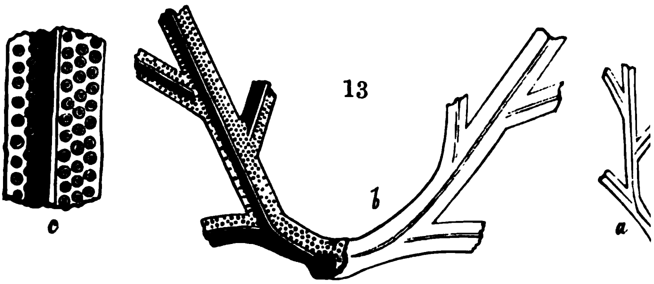

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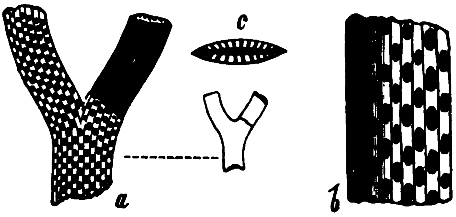

To illustrate Prof. H. A. Nicholson's paper on New Devonian Fossils.

ailway cuttings north and south of Bray Head, up to a height out 200 feet, there are shelly gravels interstratified with *Glacialoid* ; portions of the latter drift being, apparently, in both places the rmost member in the section. In the co. Wexford, according e published geological maps, most of the country below the 250 ontour line is occupied by shelly drifts; but in this area of shelly are rocky tracts or exposures of "Rocky" and Boulder-clay drift, some of the land above the 250 feet contour line is also surled by it. The shelly drift in general is more or less gravelly e south of these exposures, and to the north margin of the area; marls and clays are found to the north of the exposures and in the open spaces. Associated with these arenaceous and argillaceous nulations the *Glacialoid drift* occurs, but mostly with the latter, ailed into them or graduating into them, and in places overthem. As this *Glacialoid drift* has previously been noticed, it necessary here to repeat the description.

(*To be concluded in our next Number.*)

IV.—DESCRIPTIONS OF NEW FOSSILS FROM THE DEVONIAN FORMATION OF CANADA.

By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E.;
Professor of Natural History in University College, Toronto.

(PLATE VI.)

(*Continued from page* 60.)

Genus Productella, Hall.

hells having the general form of *Productus*, but uniformly with row area on each valve, a foramen or callosity on the ventral small teeth, and more or less distinct teeth-sockets. The reni- vascular impression, rising from between the anterior and rior occlusor muscular impressions, curves gently outwards, following a curvature somewhat parallel with the margin of iell to below the middle of its length, is abruptly re-curved, he extremity, turned a little backwards, terminates about half- etween the margin and the anterior extremity of the mesial m. The cardinal process, seen from the inner side, is bilobed, rom the exterior side each of these divisions is usually bilobed. hese shells differ from *Strophalosia* in the extremely narrow cardinal area, greater extension of the hinge-line, more ex- arcuation or ventricosity of the vental valve in many or most species, and especially in the direction and termination of the rm vascular impressions, which resemble those of *Aulosteges* f some species of *Productus*. It differs from *Productus* in the nt presence of an area, hinge-teeth, and sockets." (Hall, Pal. vol. iv. p. 153.)

ductella is considered by Hall as a mere sub-genus of *Producta;*

derable thickness of gravel. The base of this cliff is a huge kitchen-midden. uently it could not be examined. Therefore I cannot say if the upper portion of ction is typical Boulder-clay drift, or if the underlying gravels are similar to lly gravels *in the adjacent country* to the south.

but it seems to me that the articulation of the valves by distinc teeth and the presence of a distinct hinge-area are quite sufficien characters to separate the two generically. Whether *Productella* ca be kept apart from *Strophalosia*, King, is another matter, the chie characters by which the two are separated being merely questions o degree. In external appearance, however, the shells referred t *Productella* resemble *Producta* much more nearly than do those referred to *Strophalosia*.

Hall has described many species of *Productella* from the Devonia rocks of the State of New York, chiefly from the Hamilton an Chemung groups, but also from the Corniferous Limestone. I hav only met with a single species of the genus in the Devonian rock of Western Ontario; but this, though exceedingly abundant in th Corniferous Limestone of various localities, seems to be distinct fro any recorded by Hall, and I shall therefore describe it as new.

PRODUCTELLA ERIENSIS, Nicholson. Pl. VI. Fig. 10.

Shell minute, thick, semi-oval, or nearly semi-circular, the lengt about one-fourth less than the width as a general rule. Hinge-lin as wide or wider than the greatest width of the shell; the cardina angles rounded or more commonly auriculate.

Ventral valve exceedingly gibbous and ventricose, strongly an regularly arched from the beak to the front margin, but depresse towards the cardinal angles. Umbo obtuse, prominent, strongl incurved. Area very narrow and difficult to make out.

Dorsal valve depressed convex, not gibbous, depressed toward the cardinal angles. When partially decorticated, it shows very distinctly from six to eight concentric imbricating lines of growt In this condition it also exhibits a more or less defined media longitudinal ridge, which extends from a small elongated pit just i front of the umbo to the front margin—two generally stronger ridge diverging from the umbo on either side of the central ridge. Th beak is scarcely prominent, whilst there is an extremely narro linear area and a small cardinal process.

The cast of the ventral valve exhibits a longitudinal slit extendin from the beak about one-fourth or one-third of the shell, and indicating that the cavity of the beak was divided by a low mesia partition ("rostral septum"). In front of this slit there is often horseshoe-shaped elevation representing the cast of the pit wher the divaricator muscles were attached; but this is not always conspicuous. On one or both sides of the mesial slit there is als generally a slighter and shallower grove bounding the umbo laterally but the general surface of the cast is quite smooth and not pitted.

The interior of the dorsal valve exhibits radiating lines of minut pits, which cover its whole surface, or are most abundant in th central portion of the valve, and diminish as the margin is approached. Besides these, on either side of the middle line are tw pairs of deep slightly curved sulci, which extend from beneath th beak to near the margin. Those of the innermost pair are mos constant, and are placed close to the central line of the valve. Thos of the outer pair are more variable, and there are often two or thre radiating grooves on either side in place of one. Immediately beneath the beak, lastly, are placed two elongated grooves, one on each side, which only diverge slightly from the direction of the hinge-line, and extend only a short way into the shell. These are apparently dental sockets.

The surface of the ventral valve is rarely preserved, but appears to have been quite smooth. The surface of the dorsal valve exhibits faint concentric striæ. No radiating striæ can be made out, nor are there any traces of spines either on the hinge-line or upon the surface of either valve.

The width of the hinge-line of the ventral valve is two lines, the length about a line and two-thirds, and the height about three-quarters of a line to a line. The dimensions of the dorsal valve are the same, except that the height is much less. Hardly any departure from these measurements can be observed even in a large number of specimens; but a few individuals are very slightly larger, and many have the proportion of the length to the width slightly less, owing to the greater extension of the cardinal angles.

Amongst the numerous species of *Productella* described by Prof. Hall from the Devonian rocks of the State of New York, there are only *P. sub-aculeata* and *P. Fullia* which have the dorsal valve convex, all the others being concavo-convex. From these, however, as indeed from all the rest, *P. Eriensis* is distinguished by the total absence of spines and by the internal characters of both valves. There may, in fact, be some doubt as to the reference of this form to *Productella* at all, and for the positive decision of this doubt our materials are unfortunately insufficient; since, though I have examined some hundreds of specimens, I have not succeeded in finding a single example in which the characters of the hinge-line and areas are satisfactorily shown. Still, the ventral valve, in its great gibbosity, its extended hinge-line, and its produced and depressed ears, is singularly Productoid; and the presence of distinct areas on each valve, together with the fact that the valves are articulated by teeth and sockets, would remove the species from *Producta*, and would seem to warrant its reference to *Productella*. The muscular impressions in the ventral valve unluckily cannot be made out, and no help consequently can be derived from this source; whilst the interior of the dorsal valve is certainly unlike that of the typical *Productellæ*, and in some respects approaches *Leptæna*.

Productella Eriensis presents a considerable superficial resemblance to *Spirifera lorii*, Fleming; but the latter has a hinge-line shorter than the greatest width of the shell, rounded cardinal angles, both valves with mesial furrows, and a sufficiently conspicuous area. Our species is also very like *Ambocœlia umbonata*, Conrad (= *Orthis umbonata*, Conrad, and *O. nucleus*, Hall), which is very closely allied to *Spirifera lorii*. The latter, however, is distinguished from *P. Eriensis* by its very elevated umbo, the existence of a well-marked mesial sinus in the ventral valve, and the presence of a comparatively large and high area, which extends conspicuously to the cardinal extremities.

Locality and Formation.—Very abundant in certain beds of t Corniferous Limestone at Port Colborne and Hagersville.

Genus LEIORHYNCHUS, Hall.

"The shells of this genus are ovate, circular, or transverse, wi valves unequally convex, and marked by a median sinus and fold the ventral and dorsal valves respectively. The surface is plicat by rounded bifurcating plications, which are always more conspicuo on the mesial fold and sinus, whilst they often become obsolete the lateral portions of the shell; concentrically marked by stro lines of growth. Substance of the shell fibrous, usually thin. Valv articulating by teeth and sockets; the apex of the ventral val perforate at some period of its growth, the lower side being co pleted by deltidial plates. On the interior of the ventral valv two short diverging dental lamellæ extend into and are joined to tl sides or bottom of the rostral cavity; the muscular impression occ pies a narrow triangular or ovate-triangular space below the dent lamellæ. The dorsal valve has a well-defined septum, often reac ing below the middle of the valve, and divided above, leaving triangular or spoon-shaped depression. The hinge-plates are narro strong processes with sockets embracing the teeth of the opposi valve." (Hall, Pal. N. Y. vol. iv. p. 355.)

I am not in the position to pronounce any opinion as to the validi of the genus *Leiorhynchus*, or as to the propriety of separating from *Rhynchonella*, to which it is certainly most closely allied. the meanwhile, as Hall has described under this title several speci from the Hamilton and Chemung formations, I shall accept the gen for the reception of two forms which occur in the Hamilton Gro of Ontario, one of them being the previously recorded *L. multicost* Hall (= *Rhynchonella*? *Laura*, Billings), and the other being new.

LEIORHYNCHUS HURONENSIS, Nicholson. Pl. VI. Fig. 11.

Shell elongate-ovate, the greatest width being from one-sixth nearly one-fifth less than the length, whilst the greatest width placed nearly about the middle of the shell. Ventral valve conve very gibbous in the umbonal region, abruptly curving to the sid and depressed from about the middle to the front margin of t shell. A very broad and exceedingly shallow mesial sinus, which obsolete near the beak, but occupies almost all the front margin the shell, and supports about five low rounded plications. Beak the ventral valve large, prominent, and incurved, apparently n perforated by a foramen, in close contact with the umbo of the dor valve. Dorsal valve convex, strongly curved towards the sides, i centre occupied by a broad mesial fold, which corresponds with t ventral sinus, and carries five rounded plications. Margins of t fold and sinus more or less distinctly interlocking. Beak of t dorsal valve deeply buried beneath that of the ventral valve. Surfa marked with rounded plications, which are very obscure except up the fold and sinus, and which become nearly or quite obsolete in t neighbourhood of the beaks. The plications are crossed with ve *fine concentric striæ,* and with strong and very well-marked lines growth, which become close set and imbricating towards the margin of the valves.

The dimensions of a large individual are:—Length, one inch; greatest width, ten lines; height, eight lines. A smaller and narrower individual has a length of eleven lines, a greatest width of eight lines, and a height of six lines.

There is no doubt as to the entire distinctness of this species from *Leiorhynchus multicosta*, Hall, though there may perhaps be some question as to its reference to *Leiorhynchus;* since Hall states that the fold and sinus in this genus never interlock, which they certainly do in some, if not in all, of the examples of this species. In other respects there is a close general resemblance between this and *L. multicosta*, especially as regards the surface-characters, and I do not think the two species can be generically separated. *L. Huronensis* is distinguished from *L. multicosta* by its much more elongated and contracted form, the greater convexity of the valves in the umbonal region, the much more prominent and strongly incurved beak of the ventral valve, the absence of a foramen in the adult, the much greater width and shallowness of the sinus and fold, and the stronger and more crowded lines of growth. I have not seen any example which exhibits the interior.

Locality and Formation.—Shales of the Hamilton Group, Widder, Township of Bosanquet. (Collected by Mr. Geo. Jennings Hinde.)

Genus TÆNIOPORA, Nicholson.

Polyzoary calcareous, composed of a flattened linear expansion, which branches dichotomously, and is celluliferous on both sides. Each side of the polyzoary is furnished with a strong median ridge or keel, which has a longitudinal direction, and separates the frond into two lateral halves. The cells have very prominent apertures, and are arranged in from three to five longitudinal rows on each side of the central keel; the cells of contiguous rows alternating, so that a series of short oblique rows of cells are produced, which diverge from the keel like the barbs of a feather. The margins of the polyzoary are usually plain and non-celluliferous, and the cells are not separated by longitudinal striæ or elevated ridges. No fenestrules are present, and the entire frond forms a continuous expansion, within which the cells are immersed.

Two species of *Polyzoa* which agree in the above characters are not uncommon in the Hamilton Formation of Western Ontario; and their structure appears to me to be sufficiently distinctive to entitle them to be considered as constituting a distinct genus, which I propose to term *Tæniopora*, from the ribband-like form of the cœnœcium. The affinities of *Tæniopora* are clearly with *Ptilodictya;* and though there are some important points in the structure of the former which I have been unable to make out, I nevertheless find the external characters of *Tæniopora* are alone sufficient to warrant generic distinction. One of the chief characters of *Ptilodictya* is the presence of a striated laminar axis, separating the two celluliferous aspects of the polyzoary. I have not been able to establish clearly either the absence or presence of such an axis in Tæniopora, but my specimens lead me to believe that it is absent, and that there is instead a vertical septum traversing the short diameter of the frond, and prolonged on either face into a keel. Leaving this point, however, out of the question as uncertain, there remain the following differences: 1. In *Ptilodictya* the cells are not furnished with prominent mouths, but with depressed apertures, and these are arranged in rows which are separated by distinct thread-like elevated lines or striæ. On the other hand the cells of *Tæniopora* have prominent pustuliform mouths, and they are usually not separated by any lines or ridges of any kind. In some examples from the Hamilton Shales of the State of New York, the first row of cells on either side of the keel has a limiting thread-like line; but I cannot detect any such structure in our Canadian specimens, and even the former have the remaining rows of cells not marked off in this way. 2. There is no mesial keel or elevated ridge in *Ptilodictya*, by which the cœnœcium is separated into two symmetrical lateral halves. On the other hand, one of the most conspicuous features about *Tæniopora* is a strong elevated keel on each aspect of the frond, on either side of which the cells are arranged in alternating lines. 3. While some species of *Tæniopora* show a distinct non-celluliferous marginal zone, such as exists in *Ptilodictya*, others show no such character, and in any case, even when present, this zone is smooth and not striated. Upon the whole, therefore, whilst recognizing the general affinities of *Tæniopora* to *Ptilodictya*, I think the former may safely be regarded as a distinct genus. The following two species of *Tæniopora* have come under my notice from the Hamilton Formation of Canada.

TÆNIOPORA EXIGUA, Nicholson. Pl. VI. Fig. 13.

Polyzoary forming linear flattened expansions, which branch dichotomously at angles of about 60°, and at intervals of from one and a half to three lines. The width of the frond is about a line or a little over, and its thickness in the centre is about one-third of a line, from which point it rapidly diminishes in thickness till the sharp-edged lateral margins are reached. Both sides of the cœnœcium carry a well-marked longitudinal carina, which occupies a mesial position, and on either side of which are three or four longitudinal rows of cells. The cells are alternately disposed in contiguous rows, so as to form a series of short transverse obliquely-ascending lines consisting each of three or four cells. The cells are immersed in the substance of the cœnœcium, and their mouths are circular and prominently elevated above the general surface. About six cells occupy the space of one line, measured longitudinally, and the intervals between them are equal to, or slightly greater than, the diameter of the cell-mouths themselves. The cells extend on either side of the midrib quite to the edge of the cœnœcium, and there appears to be no non-celluliferous marginal zone.

From the following species, *Tæniopora exigua* is distinguished by its much smaller width, its more frequent division, its much less strongly elevated midrib, and the apparent absence of any distinct marginal non-poriferous area.

One specimen (*Fig.* 13, *a*, *b*) exhibits at the base a small conical expansion, from which the branches proceed distally, and which terminates proximally in a singular, and clearly natural, circular perforation of about one-fourth of a line in diameter. There are also indications that the branches of the frond were disposed bilaterally or radially round this central point. It is to be regretted, however, that with the imperfect materials at my command, I am at present compelled to leave this and other points of interest in the structure of this curious form unelucidated.

Locality and Formation.—Common in the Hamilton Group near Arkona, Township of Bosanquet. Also in shales of the same formation near Canandaigua, State of New York.

TÆNIOPORA PENNIFORMIS, Nicholson. Pl. VI. Fig. 12.

Polyzoary forming a linear flattened expansion, which probably divides dichotomously. The total width of the frond is about two lines, and its thickness in the middle is about two-thirds of a line, whence it gradually thins away to the margins. Both sides of the cœnœcium are furnished with an exceedingly strong, blunt, mesial, longitudinal ridge or keel, the height of which is about a fourth of a line, and its thickness about the same. On either side of the mesial keel are four rows of cells in alternating lines. The mouths of the cells are circular and prominent, about five or six occupying the space of one line measured longitudinally. Outside the rows of cells on either side is a plain non-celluliferous space, about one-third of a line in width, by which the margin is constituted.

In most of its essential characters, *Tæniopora penniformis* (Fig. 12) agrees with *T. exigua;* but it is a much more robust form, with a broader and more elevated keel, and possessing a marginal non-celluliferous area which is apparently wanting in the latter. I have only fragments of the species, and am unable to state anything as to its general form of growth or its total dimensions.

Locality and Formation.—Hamilton group, Arkona, Township of Bosanquet.

Genus PTILODICTYA, Lonsdale.

The genus *Ptilodictya*, Lonsd. (= *Stictopora*, Hall) includes a number of curious *Polyzoa* which are essentially Silurian, but which extend into the Devonian rock, and appear even to have survived into the Carboniferous period. The presence of a non-celluliferous striated margin is very usual, but hardly appears to be universal or essential; and the central laminar axis or septum, which separates the cells of opposite sides, is sometimes longitudinally striated, as well as being concentrically wrinkled. A single species of the genus, which I cannot identify with any previously recorded form, occurs plentifully in parts of the Corniferous Limestone, and, more rarely, in the Hamilton formation of Western Ontario.

PTILODICTYA MEEKI, Nicholson. Pl. VI. Fig. 14.

Polyzoary having the form of thin, very much flattened cylindrical branches, which have an average width of about a line, rarely reaching a line and a half or two lines, with a thickness in the middle of about half a line; dividing dichotomously at angles of 50° or 60°, generally at intervals of from four to six lines. No developed nc poriferous margins, the whole exterior surface seeming to be occupi by the cells. Cells tubular, curved, opening by oval mouths, ε ranged in rows, which are separated by delicate thread-like lines striæ. About ten rows of cells in the space of one line, the cells each row alternating with the next, so that the cell-mouths have quincuncial arrangement. About five cell-mouths in the space one line measured longitudinally, the interspaces between the being generally considerably longer than the long diameter of tl cell-mouths themselves. The partition or laminar axis between tl cells on the two sides of the polyzoary is marked with delicate lonɡ tudinal striæ, which correspond with the rows of cells, together wi obscure concentric wrinkles, the convexity of which is directed t wards the apex of the frond.

This species presents a close resemblance to *P. Gilberti*, Mee from the Corniferous Limestone of Ohio (Geol. Survey, Ohi Palæontology, vol. i. pl. xviii. fig. 1), with which I was at fir disposed to identify it. I have, however, been compelled to sep rate it as a distinct species upon the following grounds:—1. *Gilberti* is stated to have eight or ten rows of cells in the space two and a half lines; whereas *P. Meeki* has never less than ten i the space of one line, which would give twenty-five rows in two ar a half lines. 2. The central laminar axis of *P. Gilberti* is said to l covered with regular arched transverse striæ; whereas that of *Meeki* exhibits well-defined longitudinal striæ, with either no tran verse striæ, or with but obscure transverse wrinkles. 3. *P. Gilbert* in common with the typical species of the genus, possesses wel marked striated and non-poriferous margins; but I have bee unable to detect any traces of these in the numerous specimer of *P. Meeki* which have passed under my notice. 4. *P. Gilber* appears, upon the whole, to be a larger and more robust specie sometimes attaining a width of three lines, whereas the averag width of *P. Meeki* is only one line or a little over. I have, there fore, thought it safest to separate *P. Meeki* under a distinct specifi title, and I have named it in honour of Mr. F. B. Meek, one of th most distinguished palæontologists of America.

In some respects, *P. Meeki* presents considerable resemblance t *P. fenestrata*, Hall, from the Chazy Limestone; but in the absenc of any sufficiently detailed description of the latter species, an especially of accurate measurements, it is impossible to say hov close this resemblance may really be.

So far as at present known, *P. Gilberti*, Meek, and the presen species are the only forms of the genus *Ptilodictya* which hav hitherto been detected in the Devonian Formation.

Locality and Formation.—Common in the Corniferous Limeston of Port Colborne. Rare in the Hamilton Formation, Arkona, Town ship of Bosanquet.

Genus CLATHROPORA, Hall.

Polyzoary composed of membranous flattened expansions, whicl [illegible]r branch without anastomosis, or, more typically, divide int *es which inosculate* at short intervals, till there is produced broad frond perforated at regular intervals by rounded or oval fenestrules of considerable size. Both sides of the polyzoary carry cells; but the cells which open upon one aspect are separated from those which open upon the outer aspect by a thin concentrically-striated laminar axis or membrane, precisely similar to the axis of *Ptilodictya*. In the clathrate species, the margins of the fenestræ are surrounded by a strong striated non-celluliferous margin.

The two most important points in the above definition, namely, the presence of an axis, and the non-poriferous margins of the fenestræ, were not recognized by Hall: but they establish a very close relationship between *Clathropora* and *Ptilodictya*, and they render it doubtful if the former can be retained apart from the latter. The presence of a thin laminar axis exactly similar to that of *Ptilodictya* I have determined not only in a Corniferous species of *Clathropora*, but also in *C. frondosa*, Hall, a Niagara Limestone form, and the type-species of the genus. The striated non-celluliferous margins of *Ptilodictya* are also represented by precisely similar margins surrounding the fenestræ both in *C. frondosa*, Hall, and *C. intertexta*, Nich. It would appear, therefore, that the chief difference between *Clathropora* and *Ptilodictya* is to be found in the fact that the cells of the latter are arranged in rows separated by distinct elevated lines, which is certainly not the case in any examples of the former which I have seen, though the contrary is asserted by Hall. The mode of growth of *Clathropora* in itself clearly does not afford sufficient ground for generic distinction, and the more or less quadrangular form of the cell-mouths is merely occasional and accidental. Upon the whole, therefore, whilst retaining the genus *Clathropora* in deference to such a high authority as Prof. Hall, I am of opinion that the forms included under it may safely be considered as simply reticulated *Ptilodictyæ*.

CLATHROPORA INTERTEXTA, Nicholson. Fig. 15.

Polyzoary forming a thin flattened expansion, composed of broad branches, which inosculate so closely as to leave simply oval or rounded fenestræ perforating the frond. The width of the branches is from a line to a line and a half; and the fenestræ are oval or circular in shape, about a line and a half or a little more in diameter, and placed at intervals of about a line or a line and a half. The margins of the fenestræ are surrounded by a striated non-celluliferous

FIG. 15.

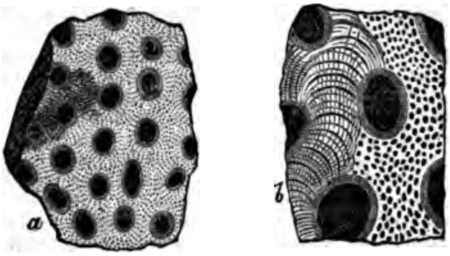

FIG. 15.—*Clathropora intertexta*, Nich. *a*. Portion of the frond, natural size. *b*. *Fragment of the same enlarged* to show a portion of the central membranous axis. *From the Corniferous* Limestone.

zone. The frond is celluliferous on both sides, forming two continuo layers, their proximal ends or bases being placed back to back, b separated by a delicate calcareous membranous or laminar axis, whi exhibits numerous close-set transverse curved striæ. From six ten cells occupy the space of a line measured diagonally, whilst t form of the cell-mouths is oval or circular, and the cells do n appear to be arranged in distinct rows separated by elevated striæ.

Clathropora intertexta is very closely allied to *C. frondosa*, Ha a beautiful and not very rare species from the Niagara Limesto It is clear, however, that Hall has included two species under th name. One of these, comprising all the specimens which I ha collected personally from the Niagara Limestone, is very readi distinguished by the exceedingly small size of the fenestræ (s Pal. N.Y. vol. ii. pl. xl. B. fig. 5 *b*), which have a diameter of on about half a line, and look simply like little oval or circular p forations in the membranous cœnœcium. The cells, also, a remarkably long and narrow, and about fourteen of them occu the space of one line measured transversely. There can be question as to the entire distinctness of this from *C. intertexta*, a I should be disposed to consider this as the type of *C. frondo* Hall. The other forms included by Hall under *C. frondosa* resem our species in their proportions and in the size of the fenest (see Pal. N.Y. vol. ii. pl. xl. B. fig. 5 *a*); but in the absence of a sufficiently detailed description, it is impossible to say that they a absolutely identical with *C. intertexta*. Should this, however, an actual comparison of specimens, prove to be the case, I shou propose that the name of *C. frondosa* should be restricted to t specimens with small fenestræ and minute close-set cells; whilst t name of *C. intertexta* should be applied to the undoubtedly distin examples with large fenestræ and comparatively large cells. any case, as before remarked, both of these species of *Clathropo* might without impropriety be regarded as nothing more than ticulated *Ptilodictyæ*.

Locality and Formation.—Corniferous Limestone, Jarvis, Townsh of Walpole. (Collected by Mr. George Jennings Hinde.)

EXPLANATION OF PLATE VI.

Fig. 10.—*Productella Eriensis*, Nich. *a.* Exterior of the dorsal valve, partially foliated, enlarged. *b.* Cast of the ventral valve of a rather larger examp enlarged. *c.* Interior of the dorsal valve enlarged. *d.* Cast of the ventral va of an example with extended ears, enlarged. From the Corniferous Limesto

Fig. 11.—*Leiorhynchus Huronensis*, Nich. *a.* Dorsal view. *b.* Ventral view of same. *c.* Side view of a larger individual. From the Hamilton Group.

Fig. 12.—*Tæniopora penniformis*, Nich. *a.* Fragment, of the natural size. *b.* Tra verse section of the same, enlarged and partly conjectural. *c.* Fragm enlarged. *d.* Fragment still further enlarged, showing the central keel a prominent cell-mouths. From the Hamilton Formation.

Fig. 13.—*Tæniopora exigua*, Nich. *a.* Portion of the frond, natural size. *b.* T same enlarged, the portion drawn in outline being conjectural. *c.* Porti of the same still further enlarged. From the Hamilton Group.

Fig 14.—*Ptilodictya Meeki*, Nich. *a.* Portion of the frond magnified to show branching and the longitudinally striated axis. *b.* A fragment enlarged s further to show the form and arrangement of the cells. *c.* Transve section enlarged. From the Corniferous Limestone.

(To be continued.)

V.—In Reply to Mr. Scrope's Observations on Mr. Mallet's Theory of Volcanic Energy.

By Robert Mallet, C.E., F.R.S.

OBSERVATIONS by Mr. Scrope on the subject to which he has so long devoted his attention demand respectful attention, and that I should endeavour to assign my reasons for not agreeing with the strictures which he has made upon my paper, read to the Royal Society in June, 1872.

I must disclaim the justice of Mr. Scrope's charge that I have thrown aside "superciliously" the labours of all preceding geologists on the subject of Volcanic Energy. I have never in my life consciously treated with other than respect the well-directed labours, in whatever department, of any man of science. In the opening sketch of my paper, which reviews past speculations as to the nature and origin of volcanic heat, truth, above all things, demanded that I should point out the baselessness of many of them. In doing this, I had the unpleasant task of pointing out that the speculations of geologists on this subject too often show an ignorance or disregard of any sound appeal to the physical and mechanical sciences while those of some mathematicians; equally unfounded, because the conditions actually existing in nature were ignored or set aside for others admitting of more convenient treatment, were yet passed current amongst geologists, because the latter either could not or would not decipher the symbols in which these unfounded speculations are wrapt up.

If I have appeared to underrate the views of geologists as to the nature and origin of volcanic heat, it is because I believe them wholly untenable when tested by the light of existing science. The older notion of the chemical origin of volcanic heat and energy so long persevered in by Daubeny and others, in the face of most obvious difficulties, at last died a natural death as a result of the examinations to which volcanic ejecta have been submitted. That which succeeded it—the so-called mechanical theory, or that of a nucleus in liquid fusion beneath an extremely thin solid crust—has already or is soon destined to give way under the searching examination to which it can be now subjected by the present state of thermotic and more especially of thermo-dynamic science. Mr. Scrope's own notions, which involve that very thin crust and liquid nucleus, as most recently formulated by him,[*] do not, I believe, materially differ from those formed and enunciated by him some thirty years ago. At that time nobody, not even the late Sir John Herschel, was enabled to test the validity of the notions current amongst geologists as to the origin of volcanic heat. It is always an unpleasant shock to admit the untenability of the views we have held and have even promulgated with more or less authority for many years, yet the progress of science, so far as these opinions may be unsound, compels us to do so, whether we will or no; it has already done so, I believe, as respects the notions still espoused by Mr. Scrope,[*] of an immense liquid nucleus and excessively thin solid crust, as well as the notion of subterranean fiery lakes, or a continuous liquid shell between the crust and nucleus. The

[*] [Mr. Mallet, in this and other passages, certainly entirely misapprehends Mr. Scrope's views, since in several papers contributed by him within the last few years to this Magazine he has expressly called in question the theory which Mr. Mallet ascribes to him. For example, this is the chief purport of two papers having for their title "On the Supposed Internal Fluidity of the Earth" [see Geol. Mag. 1868, Vol. V. p. 537, and 1869, Vol. VI. p. 145], and again in an article "On the Cause of Volcanic Action" [see Geol. Mag. 1869, Vol. VI. p. 196] he concludes his paper with these words:—"Since it has become the fashion of late among the writers of popular geological treatises to assume as a matter of fact, beyond dispute, that the substance of the globe, immediately beneath its thin superficial crust (and probably to its centre), is in a state of fluid fusion, and that the access of water from the sea above to this molten interior is the exciting cause of earthquakes and volcanos, I have thought it well to express my reasons for entertaining doubts, to say the least, as to the correctness of either hypothesis." (p. 199.) Probably Mr. Mallet has never considered these papers.—Edit. Geol. Mag.]

existence of a nucleus still in liquid fusion is a purely arbitrary assumption, and Mr. Scrope wholly misapprehends me when he affirms that the existence of such a nucleus forms any necessary part of my theory. All that I postulate is, that ours is a cooling globe, and that therefore the interior is hotter than the exterior. I know nothing as to the liquidity of the interior; and in so far as its existence can be examined by the as yet imperfect approaches of science, I am obliged to suspend my judgment, if not to disbelieve in it. Again, did such an enormous nucleus in liquid fusion exist, coated over only by a thin solid crust of some thirty or sixty miles in thickness, I believe it proveable that the surface-temperature of our globe must be greatly in excess of what it is—indeed, that the flood of heat poured forth from such an incandescent nucleus through such a thin skin, even were the conductivity of the latter as low as that of pipe-clay, would be such as to roast every organized being off the present face of our earth. Yet this gigantic incandescent nucleus and parenchymatous surface-skin Mr. Scrope and the school to which he belongs must have, or their theories are impossible. Even with such a thin skin, and the most rapid conceivable passage at its lower surface from the solid to the liquid condition, I believe it proveable that neither water could make its way through any channels that we are at liberty to suppose down to the liquid nucleus, nor liquid lava from the latter make its way up to the surface. If all this be so, then surely the time has come for substituting some theory that will better square with the facts: and such is that which I have produced. I do not at all expect that that theory will be accepted by many of the older school of Vulcanology, without the usual struggle with which new views widely differing from the old are always received by those holding preconceived and long-cherished opinions. To compare small things with great, I cannot forget that Newton's theory of Gravitation received but a partial acceptance even one hundred years after its promulgation. My paper has been but a first "attempt," as I have called it, to evolve a theory of volcanic heat and energy consistent with itself and with the facts in nature. In treating so vast and complex a subject, it can scarcely be but that future research may find numerical corrections necessary; but I believe the skeleton of the theory which I have sketched will be ultimately admitted as true: for there is no surer test of the soundness of any theory than that it not only explains the principal phenomena, but often throws the most unexpected light upon collateral ones before obscure, and with which it seemed to have no connexion; and this, as I have pointed out in my paper, is the case with my theory in several remarkable particulars.

Mr. Scrope's objections, if not very cogent or at all conclusive in my judgment, are at least so numerous that I fear want of space must compel me for the present to leave some of them unanswered. Several of his objections appear to me to rest on no better basis than that of the very imperfect grasp he has attained of the nature of my argument, and in some instances to misconceptions as to the experimental facts and their relations referred to in my paper. I do, indeed, adopt Prevost's view of mountain elevation by tangential thrusts, to which I have made allusion in tracing the successive stages of refrigeration of our planet; but it is an error to say with Mr. Scrope (p. 29) that my theory is "founded upon the assumed truth" of Prevost's views. My theory postulates nothing more, so far as volcanic action is concerned, than that our globe is still a cooling one, and subject to the known physical conditions of cooling bodies. It would remain equally true, whatever view might be taken as to the mode of elevation of mountain chains. It is a fact, however, that mountain elevation and existing volcanic action are but successive phases of the same play of forces.

It seems to have escaped Mr. Scrope's observation, that I have done more than to merely adopt Prevost's views. I have, I believe, been the first to point out the complete succession of connected phenomena produced by contraction during the secular refrigeration of our globe from its condition of liquid fusion.

It had not before been seen by any writer, so far as I know, that while the solidified crust is very thin, the tangential strains therein were tensile, and that, as the crust thickened, these were gradually reversed in direction, and became tangential thrusts. Admit this, which is rigidly demonstrable to be true, and it then follows inevitably that in the earlier epoch the wellings up of fused material from *beneath were* due to subsidences of the crust, and, as I have called it, hydrostatic, *and of a nature entirely* distinct from existing explosive volcanic action. The change of signs in the directions of the play of forces was no doubt gradual, and whether it took place at one or at another geological period is immaterial to the truth of my theory of existing volcanic action, which might remain true, were we to suppose that such a change of action never took place at all.

Mr. Scrope founds an objection to my theory, "that it seeks and purports to find a second source of heat where one exists fully sufficient for the purpose." Were I to admit with him his hypothesis of the existence of a fused and liquid nucleus within a few miles of the surface, his remark would be in so far true; but as I neither postulate nor even admit the existence of such a source of volcanic heat, there is no superabundant hypothesis involved in my view. The transfer of heat into space from our cooling globe is the *primum mobile* of all existing volcanic action. The heat lost gives rise to mechanical work at a certain stage in the complex train of phenomena called into play by its loss, and part of that work is transformed into heat, which is that of volcanic action.

It is mere verbiage to talk of this transformation of work into heat as involving any second source of heat, it being derived primarily from the only source conceivable, namely, the hotter interior of our planet. When a "billet" of iron is taken from the furnace and passed between the rollers, its temperature rapidly and visibly augments by reason of the violent distortion to which the heated mass is subjected. Would it be any philosophical objection to the true explanation of the phenomena to say that the increased heat of the bar was derived from a second source, and not from the furnace? If the interior be not in liquid fusion, of which we have no proof whatever, or being assumed in fusion if it be covered by a solid crust of even two or three hundred miles in thickness, then I affirm that there is no other conceivable way in which we can find a source of volcanic heat and energy, except that which I have pointed out.

An objection is made by Mr. Scrope, that of the three ways in which heat is lost by our globe,—viz. by conduction, by which I presume he means radiation into space, by hot springs, and by volcanic vents,—I ascribe the two former to direct cooling, and the last to an entirely distinct and independent origin. There is here surely a strange confusion of ideas. The heat—which is the transformed work of contraction and source of volcanic action—has no distinct and independent origin; it is merely one form of the actions brought into play by the loss of heat due to radiation into space. Again, as a matter of fact, Mr. Scrope is quite in error in saying that I ascribe the heat of thermal waters exclusively to hypogeal heat directly brought up by them. The great mass of thermal waters issue at far below 212° Fahr., and their feeble heat in the vast majority of instances is no doubt due to surface-waters penetrating the earth to a small depth, and returning more or less heated by it; but I have nowhere denied, even suggestively, that waters are also evolved at the surface, heated by direct connexion with or proximity to volcanic vents. However heated, they are but one form of the complex phenomena of our cooling globe, of which the volcano is another. Mr. Scrope seems to have failed to remark that my estimate of the annual heat lost by all the thermal waters in the world proves that their total refrigerative action is insignificant; we may dismiss them from consideration as affecting my theory.

Mr. Scrope says (p. 29), "There is no difficulty in understanding how the great fissures in the solid crust of the globe, which are marked outwardly by active, or once active, volcanoes, may penetrate so far into the interior of the heated nucleus as to give vent to an amount of heat sufficient to fuse the rocks through which they pass, and to some of the already fused or viscid underlying matter." To me there is every difficulty. Assuming a liquid nucleus, of which there is no proof whatever, covered by a solid crust of some hundreds of miles in thickness, it is, I believe, demonstrable that no open fissures could penetrate through such a crust; and if they did, the liquid matter could not reach the surface through them. Can I rightly understand Mr. Scrope to say that his open fissures would pass up heat from the nucleus better than the solid rock forming their walls? If so, this seems to repeat the error as to the heat-wave of some of the earlier writers on earthquakes, who imagined that the wave of shock passed more readily through cavernous fissures in the earth than through its solid mass. If this be the insecure basis upon which Mr. Scrope has founded the solution—to which he refers—of the great inequalities in the increments of hypogeal heat nearly everywhere observable, —viz. its lateral transfer when stopped by *badly conducting strata* to such open fissures;—or even if we assume his fissures full of water, with a copious surface supply,—then would his solution signally fail to account even for such differences of increments as can be traced to the differences in conductivity alone. But Hopkins, in one of the most valuable of his papers, has shown that there are differences of increment not traceable to conductivity alone, and for which he was unable to offer any explanation. Facts also have been observed since his time which cannot be accounted for upon Mr. Scrope's notions: such as a continued increment, and then a decrement of hypogeal temperature, again becoming an increment, in the very same shaft; two shafts, alike as to wetness, not far apart, in the very same formation, extending to a vast depth below, and extending for miles all around, and yet showing great disparity of increment; two shafts not far apart, in different rocks, extending far around in every direction, but in the line joining them, and yet with differences of increment the very reverse of those due to conductivity alone. For these and other like cases Mr. Scrope's views, even if physically well founded, would offer no solution whatever. It is, however, as I have already briefly remarked, one of [illegible] striking confirmations of the truth in nature of my theory that it does, as a collateral consequence, offer a complete and consistent solution of this previously unsolved puzzle—viz. the immense inequalities in hypogeal increments.

I have shown in my paper (Phil. Trans. part I. vol. for 1873, p. 168, p[illegible] 69 to 75) that these inequalities are due to the different amounts of work expended in the horizontal compression of strata, varying in compressibility or resistance when transformed partially into heat; work which is now going on more or less within every part of the superficial crust of our globe. The heat thus produced may in places be so slight as scarcely to affect the thermometer; while at others, as my theory declares, it may rise to the highest temperature of volcanic action. The source to which I attribute volcanic heat and energy is not a mere local phenomenon existing alone along the lines of volcanic vents, but is a great cosmical condition pervading every part of the thick and solid crust of our globe, and varied only in degree at one place or at another, dependent upon the amount of work expended at any point, and transformed into heat in the unit of time.

Mr. Scrope suspects that I have but an imperfect acquaintance with the phenomena of volcanoes in eruption, and then proceeds to say, "or he would not speak as he does of the expenditure of heat in the explosions of steam from a volcano in eruption as 'not resembling that which takes place in a steam engine, but rather that of powder exploded in a cannon, the loss from which is shown to be much smaller.' The contrary is really the case; the explosions from a volcano in activity resembling precisely in character (and apparently in cause) those of a Perkins steam-cannon fed by a continuous escape of steam from a boiler." Mr. Scrope has here made a giant of his own, founded upon an almost ludicrous mistake as to my meaning. I have not said one word in any part of my paper, or in paragraphs 189–190, about the resemblances to either steam engine or cannon of the explosive efforts seen at volcanic vents in eruption. I am, in the passage quoted, referring simply to the amount of *waste of heat* that should be allowed for as most probable in estimating the total amount of heat annually expended to produce the existing volcanic phenomena of our globe. The waste of heat due to lifting action in eruptions by steam blown off uselessly is, no doubt, as Mr. Scrope says, immense; and I have made an immense allowance for it by assuming that every three units of heat thus expended only do the lifting work of one. I have, as I conceive, made a most ample allowance in my estimate of the annual heat required for existing volcanic action, for that which is usefully consumed or wasted in the three great operations of melting the solid ejecta, vaporising the gaseous ones, and lifting the whole to the height ejected. But whether my figures be accepted as exact or not, I have also shown that the heat annually lost by radiation from our globe (which, as Mr. Scrope calls it, is the *primum mobile*) is so vastly in excess of that which is demanded to account for all existing volcanic action, that Mr. Scrope may, if he pleases, increase by some hundreds of times the expenditure I have assigned, without the result affecting the validity of my argument.

As to Mr. Scrope's suspicion that I have but an imperfect acquaintance with the natural phenomena of active volcanoes, my own field of personal observation has been, [illegible] believe, not very far from co-extensive with his own; but besides my own personal observations, which have neither been few nor unsystematic, I have made diligent [illegible] of *the eyes and* observations of others, and readily acknowledge the debt I owe in this respect to Mr. Scrope himself, over whom I have possessed this advantage, whatever it may be worth, that my volcanic travels have been made not before, but since, the state of thermotic science and of other branches of physics has enabled measure and quantity to be applied to such phenomena. It is not upon the vastness of field of observation, but by the combined "eye-sight and insight" with which chosen portions of it may be regarded that the interpretation of natural phenomena depends. Von Buch and Humboldt afford us a remarkable illustration of this. Both possessed almost unrivalled opportunities of volcanic observation, yet to neither, so far as I am aware, do we owe a single important advance in volcanic theory.

I have nowhere denied, as Mr. Scrope assumes, that the preponderant portion of the ejecta constituting volcanic cones has been *at some time or other* in a state of fusion. What I have affirmed, and taken as part of the basis of my estimate, is, that *in any one eruption*, and upon the average of all known volcanoes, not more than one-twentieth of the matter ejected is *at that time* reduced to the condition of liquid fusion, the rest being merely more or less highly heated, but not to the fusing point. I believe a majority of those who have best examined the subject will agree with me in this.

Mr. Scrope also objects that I have not taken into account "the dust carried away by the winds or waves, and scattered over thousands of square miles of the surrounding areas." But this again is not so. I have included all dust and fragmentary matter in the nineteen-twentieths of ejecta heated to below fusing point, and I believe most amply allowed for its mass. The mass of dust carried to any considerable distance by the wind is relatively very small, and of that carried away at present by sea-currents we know simply nothing. Were I to admit Mr. Scrope's objections here as valid, and add as largely to the heat expended in each eruption as he could show any reasonable ground for, the increased numerical result would not in the least degree invalidate the argument of my paper, in which I have proved that the total amount of heat annually carried off from our globe by existing volcanic action cannot by any possibility exceed the $\frac{1}{1589}$ part of the total heat annually dissipated from our globe. I may extend this remark to nearly the whole of Mr. Scrope's objections in other directions, which merely cavil with my numerical data, without supplying any better or more exact ones, and which in any event do not affect my argument, or the theory, deduced from it. I must pass almost without notice Mr. Scrope's energetic denials of my view, that on the whole the most ancient volcanic activity observable on our globe's surface was hydrostatic, and not explosive in its character, as at present. Some of his objections rest on mere misconceptions of my views, and all are asserted rather than proved; and whatever view be taken as respects this, does not affect the validity of my theory. The "unauthorized notion of the existence of vast masses of 'dust' beneath the earth's crust," which Mr. Scrope attributes to me, and which, he says, "pervades much of my theoretical view of the cause of 'hypogeal disturbances,'" has no existence but in his own imagination. I have nowhere even suggested the existence of any such masses save in proximity to volcanic foci and vents, and from which it is the province of the volcano to dislodge them.

The most sweeping objections to my views urged by Mr. Scrope are to be found at pp. 31, 32, commencing with the words "But the data for forming any opinion," etc. The remarks here made by Mr. Scrope arise from a radical misconception of the nature of my argument, the very basis of which he does not seem to discern. Observations, long continued at Paris and Edinburgh, prove that the annual loss of heat from our globe at present is equal to that necessary to melt 777 cubic miles of ice at zero to water at the same temperature. It is a result as well assured as most physical data dependent on continued observations, and sanctioned by the authority of such men as W. Thomson, the late J. D. Forbes, Elie de Beaumont, etc.; it is certainly not above the truth, but may probably be considerably *below* it. Having ascertained experimentally the units of heat evolved from the unit of volume of mean rock crushed,—that is, the mean of the various rocks of the whole series of formations,—I am enabled to determine how many cubic miles of such mean rock, if crushed, would evolve as much heat as that annually lost by our globe. So far, the numerical data by which I have tested my theory do not admit of dispute. The theory itself—viz. that volcanic heat and energy are due to the mechanical work and its transformation into heat incident to the cooling of our globe—stands firm, and is wholly independent of these numerical data. But to test the credibility of my theory, I bring it into contact with these numerical data; and it is only necessary to show that, making an ample estimate of the amount of heat demanded by the volcanic action annually expended upon our globe, its total amount *does not exceed* that due to the total heat annually lost by radiation, or in any other way, measured in terms of melted ice or its equivalent in crushed mean rock. If the annual volcanic heat were equal to or exceeded the total heat annually lost by our globe, then the theory could not be true; but if, as I have shown, the total annual heat of volcanic action be but a minute fraction ($\frac{1}{1689}$) of the total annually lost by radiation from our globe, then a strong corroboration is afforded to the credibility of the theory itself, which really rests upon the indisputable fact that crushing and its physical consequences *must* take place in the outer portions of a cooling globe such as ours. It is therefore mere waste of time to cavil with the numerical data upon which I have based my estimates of the heat annually expended in volcanic energy, unless it can be shown that these are numerically deficient and require correction, not by adding to them to the extent of two or three fold, but to that of fifteen hundred fold or more. No one will affirm that my estimates, which are in several respects ridiculously ample and beyond all probable truth, are in error of deficiency to the above enormous extent; and if not, my argument remains untouched.

Mr. Scrope also objects to the validity of my experimental results as to the heat evolved by crushing rock specimens, as applied to our subject, in a way which I cannot avoid saying betrays much want of clearness as to the physical conditions involved. He says, "These crushing experiments being made upon small cubical blocks in a dry state, at the temperature of 57°, and subject on four of their sides to no other resistance than that of the atmosphere, are wholly inconclusive as to the effect of pressure on similar rocks miles under ground, permeated with water, at temperatures probably far exceeding 1000°, and in contact on all sides with resisting media at least as unyielding as themselves. How is it Mr. Scrope does not see that if a cube of rock, crushed by pressure on two opposite faces, the other four sides being in free air, requires a certain amount of work, it will require more work in proportion when these four sides are supported by other material, and that if there be more work thus expended, there must be more heat produced by its transformation? Now the store of crushing power in our globe is practically limitless, exceeding, as I have proved, the resistance to crushing of the most resistant rocks known to us by nearly five hundred fold. This objection therefore, rightly interpreted, is an *à fortiori* argument in favour of my results. But then my crushed cubes were dry. They were not dryer than rock not watersoaked usually is. What does Mr. Scrope *know* of the wetness or dryness as to imbibed moisture, or even as to the very nature of any rock at even thirty miles, not to say a hundred miles or more in depth? They are certainly not likely to be generally watersoaked, or even capable of imbibing water; and if they were so, can Mr. Scrope prove that they would necessarily require less work to crush them? But my experiments were conducted at the temperature of the atmosphere only. Is Mr. Scrope prepared to prove that rocks heated to 1000° necessarily require less work to crush them than at 57°? It is certain that fire-brick, which is an artificial clay porphyry or a sandstone, millstone grits, and many granitic rocks, and generally most neutral and basic silicates, offer about as much resistance to crushing at temperatures of 1000° or even more, in fact up to within a few degrees of their fusing points, as at ordinary temperatures. This is a fact illustrated every day in the construction and use of our blast and other furnaces, and in the well-known results of conflagration upon the materials of our architectural structures. As to the further objection urged, that I have paid no regard in these experiments to the effects of great pressure in raising or lowering the fusing point of rocks exposed to it, I have not left that quite disregarded in my paper, and I feel that it would be superfluous to seriously discuss the objection. The limits within which the fusing temperature of rocks can be raised or lowered by differences of pressure only are unquestionably extremely small, so small that I believe the results cannot ossibly play any important or leading part in geologic phenomena. The fact of ch differences existing at all is far from certain; it has merely been analogically *rred from a few* experiments on spermacetti and wax, etc., and on ice, all, except the last, of little certainty. The limits of difference have never been even analogically assigned by any physicist, and they are certainly smaller as the rigidity is greater and the fusing temperature of the body is higher. The notion was seized upon by Hopkins, with but little examination, as offering some feeble support to his wild hypothesis of subterranean lava lakes.

Mr. Scrope thinks that my theory "fails to account for the fact that volcanic eruptions are almost wholly confined to certain lines or bands traversing the earth's surface," which, he goes on to say, "indicate the existence through long geologic ages of great rents in the solid crust, the direction of which is generally parallel to the coast outlines of the continents or the axes of their mountain ranges." (p. 32.) My theory, as pointed out in my paper, does adequately account for the arrangement of volcanoes such as we find them, because it is along these bands that we can see must have existed the lines of least resistance to crushing after the mountain elevatory work had been done. Let me ask, on the other hand, what rational solution of the observed arrangement of the volcanic and accompanying seismic bands on our globe, which are not always coast-lines, but often cross the seas and oceans, is afforded by either the old, and as I regard it exploded, notion of a universal ocean of molten lava beneath an excessively thin crust, or by Hopkins's hypothesis of fiery lakes scattered within a solid and very thick crust? If we had the universal ocean of molten lava within thirty or sixty miles of the surface, why should it confine its visits to the latter to any linear arrangement? Why should not the greater number of volcanoes be found about the tropics, where, upon any theory of cooling of our globe, the crust, no matter how thick, must be the thinnest? And why should we have any volcanoes at all about the neighbourhood of the Poles? Or, again, why should Mr. Hopkins's fiery lakes be arranged in lines, or in any other way, unless scattered *par semé* over land and sea bottom? It is absurd to discuss the possibility of existence of the deep open fissures imagined by Mr. Scrope along coast-lines or anywhere else in our globe, after what the Rev. O. Fisher and I have proved as to the enormous tangential pressures existing in the earth's crust, which must crush into contact the walls of all such fissures with a force nearly 500 times greater than the resistance of solid granite or porphyry.

Mr. Scrope remarks that I "follow those geologists, Lyell, etc., who consider eruptions to be occasioned by the influx of water from seas or lakes above through fissures into foci of heated lava below. And that I reject as wholly untenable the notion that water could have originally existed in molecular combination with the crystalline matter of the rocks before they were melted into lava." Surface water must in some way reach volcanic foci to account for the phenomena observed at volcanic vents, and the theory held by Mr. Scrope, whether originating with him or not, and by a few other geologists, that the water from which the steam issuing from volcanic vents is formed has been derived from water either chemically combined or vesicularly contained in the rocks from which the lava has been formed, is wholly untenable. It follows, therefore, that Mr. Scrope's favourite notion that the expulsion of volcanic ejecta is due to the expansion by heat of such combined or vesicular water, and that the lava rises in and is expelled from the vent by what he calls its "intumescence," by a process which he has himself likened to the frothing forth of a bottle of champagne, is utterly untenable, being inconsistent alike with the phenomena and with the physical laws upon which it is supposed to be founded. If Mr. Scrope will recur to paragraphs 210 to 218 inclusive of my paper, I think he will see that he has overlooked much that I have there said, and in part (no doubt unintentionally) represented the very opposite of my meaning. So far from admitting that there is no limitation to the depth to which water may percolate, I distinctly state that "it is only to such depth as water can percolate or infiltrate by capillarity that the deepest focus of volcanic activity can be found." (par. 211.) Nor, of course, do I deny that rocky masses may be fused in contact with water at a sufficient temperature and pressure. But I do deny that such water can be the source from which the steam of volcanic eruptions is derived.

I can but glance at the objections to Mr. Scrope's view. To treat it thoroughly would require a whole part of this JOURNAL or more. What does any geologist *know* of the rock thirty or sixty miles deep? That it is hydrated or hydroferrous at these or much greater depths, not to say that the still deeper molten rock *of the nucleus is so, is* a mere assumption. But let us admit that it all, at whatever depth, holds as much water as the most highly hydrous igneous rocks known at our surface,—that is, at a maximum about two, and on the average less than one per cent. by weight. Has Mr. Scrope ever calculated what supply of steam for elevation and waste this would afford him from a column of his liquefied hydrous rock of, say, a mile square, and sixty miles in depth? The pressure at the base of such a column of the density of granite would be more than 20,000 atmospheres. Has Mr. Scrope ever considered what amount of expansion his vesicular water could undergo under such a pressure and at a temperature equal to that of melted lava, or, if he likes, much higher? Has he considered the bearing on this of Dr. Andrew's late researches upon the expansion of liquids at great pressures and temperatures, and of the temperature at which it is probable from these "the critical point" for water is reached, or the effect upon the temperature of the column of the steam bubbles expanding in proportion to their distance from the base? Suppose these and other formidable physical difficulties removed, and that such a column could be lifted by the machinery assigned, the expansion of the evolved steam is at every point in the height of the column, whose temperature we may even grant to be constant throughout, proportionate to its depth in the column; it is, as we have supposed, 20,000 atmospheres at the base, and one atmosphere at the top of the column. Once this equilibrium is obtained, even slow frothing over or overflow of the column at the surface, much less reiterated spirting and ejection, is impossible. Any analogy to the champagne bottle is merely delusive. But again, how can we account on such a mechanism for that pulsatory ejective action which characterizes all volcanic eruption?—for those roaring blasts of steam, recurrent at uncertain intervals, which Mr. Scrope himself has so well referred to, in the preceding part of his remarks, as resembling the volley discharged from a Perkins steam-gun?

If Mr. Scrope will recur to the par. 210 to 218 of my paper, he will find that I do not reject any of the causes usually assigned for the irregularity, intermittence, recuperation, change of position, etc., observed at volcanic vents; but I say that to account for these phenomena something more is wanted. We must have some adequate cause for variation of the volcanic energy itself at its focus. Those requisite conditions my theory supplies; but it is wanting to the older notion; for whether the source of energy be derived from a universal subterranean ocean of molten rock, or from Hopkins's fiery lakes, that energy must be constant, subject only to an insensible secular decay. I do, indeed, say that it is but a partial view to affirm that volcanic eruptions can act as safety-valves to prevent earthquakes; though it is needless I should occupy space here by showing my grounds for that opinion. Mr. Scrope, however, wholly mistakes my meaning when he goes on to say (page 34): "Yet he himself argues that his crushing mechanism for producing the heat at intervals, which gives rise to volcanic eruptions, obviates the occurrence of paroxysmal 'Cataclysms' which would probably destroy all living things upon the globe's surface. And what can be meant in this connexion by 'Cataclysms' but earthquakes of tremendous violence?" What I do mean is made perfectly clear by the paragraph of my paper, 221, which I commend to Mr. Scrope's re-perusal. Were there not the self-adjusting mechanism by which the volcanic energy produced is just sufficient at very short intervals to remove a proportionate amount of material to enable our earth's crust to subside, but that such subsidence should be delayed for long intervals, then at last the crust would become to such an extent unsupported as to produce not only earthquakes, but such tremendous crushing together and rending as must suddenly destroy the terrestrial regimen upon which the existence of all organized life depends.

Mr. Scrope concludes by saying, "On the whole I admit the plausibility of Mr. Mallet's suggestion that some local development of heat must attend the crushing and squeezing of rocky matter during the internal movements to which their fractures and contortions, as well as the slaty cleavage of many, prove them to have been subjected." This is cloudily expressed; but if Mr. Scrope means, as he must be understood to do, that these crushings are still going on, then I am content to accept his admission, though expressed with a minimum amount of approbation, because it in effect admits my entire theory. *All the objections in his remarks, numerous as they are, are mere questions of "how much"; they are,* in fact, mere cavillings with the numerical data upon which I have sought to test the validity of my theory. The theory is nowhere impugned by him. My "estimates" of the annual expenditure of volcanic energy do not profess to greater exactness than the imperfect state of our topographical knowledge and the state of science will admit. They will be subject, no doubt, to future correction, though I am sure without endangering the theory itself which they illustrate. I cannot but remark that while Mr. Scrope has objected to my numerical data, he has not in a single instance supplied in numbers any betters ones, which, as it seems to me, every scientific objector is bound to do. Mr. Scrope ends by declaring that he "prefers" his own old notions to my new ones. That is natural; but we must all yield in the end to the progress of truth, and to this I am sure Mr. Scrope, whose truth love and candour I know from personal intercourse, will, I hope, live to prove no exception.

NOTICES OF MEMOIRS.

MINERALOGY.

I.—Mineralogical Observations on Brochantite. Mineralogische Beobachtungen: V. Von Dr. Albrecht Schrauf. *Sitzungsb. d. k. Akad. d. Wissensch.: Math.-Naturwiss. Classe.* lxvii., 1873. pp. 275–360.

THIS Paper, which forms the fifth of a series of communications presented by Dr. Schrauf to the Vienna Academy, is devoted, for the most part, to a discussion of the crystallography of Brochantite. Several minerals, differing from one another both chemically and morphologically, have hitherto been grouped together under this specific name; and, although our knowledge of many of these varieties is still imperfect, yet the author feels justified in referring them to four distinct types, namely:—(1). The Brochantite of Rézbánya in Hungary, of which two varieties (*a* and *b*) are recognized; and some of the Cornish and Russian Brochantites. (2). The Waringtonite of Cornwall, and a third variety (*c*) from Rézbánya. (3). The Brochantite of Nischne-Tagilsk, in Siberia. (4). The Königin of Russia, and a fourth variety (*d*) from Rézbánya.

Dr. Schrauf points out the relation between the crystalline forms of Brochantite and those of Malachite. Just as Malachite was originally described as prismatic and subsequently determined to be monoclinic, so it appears that careful measurements of Brochantite tend to remove it from the prismatic system. The author believes that some varieties of Brochantite are monoclinic and others triclinic.

In addition to the crystallographic details, the paper includes a comparative review of the paragenetic and chemical relations of the Brochantite group of minerals.

Two folding-plates of crystalline forms and projections accompany the memoir.

F. W. R.

II.—The Fibrous Quartz of the Cape, a Pseudomorph after Krokydolite. Der Faserquarz vom Cap, eine Pseudomorphose nach Krokydolith. Von Herrn Dr. F. Wibel. *Leonhard u. Geinitz's N. Jahrb. f. Mineralogie u.s.w.* 1873, Heft iv. pp. 367–380.

IT is a curious fact that whilst quartz so commonly occurs crystallized, *it has rarely been observed* in distinctly fibrous forms.

The best-known example is that of the so-called fibrous qua
South Africa. The object, however, of the present paper is to
that this substance is not an original form of quartz, but is n
a product of pseudomorphism, in which the fibrous struct
a pre-existing mineral has been retained.

Dr. Wibel has examined two varieties of this African min
the one brown, and the other blue. The brown variety occ
the form of bands in a highly siliceous brown ironstone. An
of the fibrous mineral showed that it contains—silica, 57·46;
oxide, 37·56; water, 5·15. Treated with hydrochloric acid, th
is removed, and a white fibrous siliceous material is obt
Hence the author concludes that the brown mineral consist
mixture of white quartz and ferric hydrate in the form of G
($Fe_2O_3 \cdot H_2O$).

Analysis of the blue variety yielded the following resu
silica, 97·27; ferrous oxide, 1·67; lime, 0·15; soda, not detern
water, 0·76. The author is led to regard this variety as a m
of white quartz with blue krokydolite. He believes that
varieties are pseudomorphs after asbestiform krokydolite; the
being the product of a perfect and slow alteration, the blu
of an imperfect and rapid alteration.

Since writing his paper, the author has had an opportun
studying microscopic sections of both varieties of pseudomo
quartz; and he states, in an appendix, that these observations e
agree with the conclusions which he had previously expressed.

F. W.

PETROLOGY.

III.—NOTE ON THE BASALT AND HYDROTACHYLYTE OF THE ROS NEAR DARMSTADT. Notiz über den Basalt und Hydrota des Rossberges bei Darmstadt. Von Hern Dr. Th. PET *Leonhard u. Geinitz's N. Jahrb. f. Mineralogie, u.s.w.* Heft iv. pp. 385–390.

THE following minerals have been detected as constituents
Rossberg basalt, namely—augite, olivine, nepheline,
iferous magnetite, apatite, a plagioclastic felspar, leucite,
melilite, and hauyne or nosean. As products of decompositio
basalt yields osteolite and certain zeolitic minerals. The ost
which has recently been worked commercially, occurs in
veins running through the decomposing rock. A specimen o
osteolite, dried at 100° C., yielded 34·7 per cent. of phosphori
(P_2O_5), corresponding to 75·7 per cent. of calcium orthophosp

The substance described some time ago by Dr. Petersen und
name of *Hydrotachylyte*, is found in certain parts of the Ro
basalt. A peculiar vitreous variety of tachylyte also occurre
pellucid bottle-green obsidian-like mass, inclosed in the rock.
Petersen publishes his analyses of both these substances, and
pares their composition with that of true tachylytes from
localities.

These analyses may be usefully reproduced.

	I.	II.	III.	IV.	V.
Silica	51·08	54·93	55·74	66·42	47·52
Titanic acid	1·24	0·28	...	0·31	1·13
Alumina	16·38	19·36	12·40	13·07	17·35
Ferric oxide	4·27	3·68	13·16	3·66	4·36
Ferrous oxide	7·33	6·48			3·05
Manganous oxide	0·31	0·06	0·19	trace	0·26
Magnesia	2·07	2·16	5·92	1·30	4·07
Lime	8·12	6·27	7·28	1·19	1·85
Soda	6·12	3·14	3·88	6·09	2·38
Potash	3·63	0·73	0·60	7·36	4·63
Phosphoric acid	0·05	0·04	...	...	...
Chlorine	trace	trace	...	...	...
Fluorine		...	...	...	...
Water	0·78	2·16	2·73	0·73	12·90
	101·38	99·29	101·80	100·13	99·50

I. Tachylyte; Bobenhausen; by Möhl. Spec. grav. 2·686.
II. Tachylyte; Sababurg; by Möhl. Spec. grav. 2·757.
III. Tachylyte; Säsebühl; by Schnederman. Spec. grav. 2·578.
IV. Tachylytic Glass (*tachylytisches Glas*); Rossberg; by Petersen. Spec. grav. 2·524.
V. Hydrotachylyte; Rossberg; by Petersen. Spec. grav. 2·130.

F. W. R.

IV.—Brief Abstracts for 1873.

Tregay, Capt. William. Some Remarks on Crossbranches and Crossheads; being an Inquiry into their Effect on Mineral Lodes. *Rep. Miners' Assoc. Cornwall and Devon for* 1872–3, pp. 57–61.

By crossbranches are meant small local branches, sometimes only extending the breadth of the lode they traverse. The details of some of these are considered, and it is concluded that in many cases they have a beneficial effect on the lodes, when they are filled with carbonate of lime; whilst when they are hollow or filled with quartz, the lodes are less productive.

Collins, J. H. (1). Note on the Rocks and Goonbarrow Mines, near St. Austell. (2). Note on the Evidences of Vertical Movement in the Lodes of Cornwall. (3). Note on the Iron Deposits at Smallacombe, in Devonshire. *Rep. Miners' Assoc. Cornwall and Devon for* 1872–3, pp. 66–71.

(1). The mines are worked for tin and iron. There is a large open work in a hill of granite (the felspar of which is in parts decomposed, forming china-clay), crossed by tin-lodes. A plan and section are given. The hard schorlaceous bands in the granite give evidence of pseudomorphism on a large scale, and are more like veins of segregation than true fissure veins. In the lodes crystals of felspar have been replaced by quartz, schorl, and cassiterite.

(2). A *tin-lode at East Rocks* Mine, near St. Austell, is inferred to be in a line of fault, along which there has been movement at a comparatively recent period, since the deposition of some fathoms of the superficial deposit.

(3). The estate consists of Killas traversed by diorite (much decomposed at top). The ores are limonite and magnetite, the former in irregular layers of nodules in a thick mass of sands and clays; the latter as beds of variable thickness in the greenstone. The hæmatite is being worked in an open quarry.

Tilly, Henry. Particulars of a Thermal Spring at Wheal Seton Mine, in the Parish of Camborne. *Rep. Miners' Assoc. Cornwall and Devon for* 1872–3, pp. 53–56.

The spring is about 140 fathoms below the surface, and discharges 30 gallons a minute, at a temperature of 94° Fahr. The water is moderately clear, but brackish. Analyses are given, from which it is seen that a gallon of the water contains as much as 1072 grains of solid matter.

Collins, J. H. On the Mining District of Cornwall and West Devon. *Proc. Inst. Mechan. Eng.* (*Birmingham*) *for* 1873, pp. 89–118. 15 Plates (Map, Plans, and Sections).

The geological structure of the district is first described. The fundamental rock is granite, upon the flanks of the masses of which rests the Killas or slate-rock, which is of variable composition, but generally more crystalline near the granite. The mineral lodes are next noticed: they are most numerous near the junction of granite and slate, especially those of tin and copper, whilst those of lead and iron are often found far off the junction. The different veins are true fissure-veins, often in lines of faults, and they are very often displaced by faulting: their mean directions vary in different parts. Both granite and slate are traversed by intrusive igneous rocks, the elvan dykes occurring chiefly near, and the diorites further off, the granite. The diorites sometimes seem to improve the ore, but sometimes not, whilst the elvans are often very beneficial: the majority of the latter have a general east and west direction, and some have been traced for 12 miles. The method of working the tin and copper mines is then described, and the iron ores and china clay are noticed.

1874.

Mello, Rev. J. M. The Midland Coal Field. Pp. 135–140 of "the Derbyshire Red Book," with Map and Section. 8vo. *Derby.*

The author notices the probable former continuity of some coalfields, which have since been separated, through upheaval and denudation; describes the extent of the Midland Coal-field (half of which is concealed by overlying beds); notes the estimates that have been made of its probable underground extension eastward; and gives an account of the Derbyshire Coal-measures and of their associated bands of ironstone, with a vertical section of the beds.

W. W.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I.—January 21, 1874.—Prof. P. Martin Duncan, F.R.S., Vice-President, in the Chair.—The following communications were read:—

1. Extract of a Despatch from Mr. Williams, H.M.'s Consul at Samoa, dated Sydney, October 28, 1873. Communicated by H.M.'s Secretary of State for Foreign Affairs.

"The afternoon before I left [Samoa], samples of gold in quartz were put into my hands, found by three Englishmen in a valley about three miles from the port of Apia, but not having visited the spot I cannot vouch for the discovery, but I have every reason to believe that the gold is there; and I have had the samples assayed here, and the yield is at the rate of 3000 ozs. to the ton."

2. "The Secondary Rocks of Scotland.—Second Paper. On the Ancient Volcanos of the Highlands and their Relations to the Mesozoic Strata." By J. W. Judd, Esq., F.G.S.[1]

Discussion.—Mr. Campbell thanked the author for having taught him so much concerning a district in which he had been born and bred.

Mr. D. Forbes was gratified to find the subject of the igneous rocks of Britain taken up in so able a manner, and the subject not left entirely to continental geologists. The author was fortunate in the fact that he had occupied the same ground as that which had already been explored by Prof. Zirkel, whose work had been thus supplemented. He agreed with the author in regarding Volcanic and Plutonic rocks, from granite down to the most recent lavas, as of one and the same origin. He suggested a doubt whether the older granites belonged to so recent a period as that assigned to them by the author.

Prof. Maskelyne considered that this paper would go far towards settling the question between one half of the petrologists of the present time and the other half. He accepted the author's view as to the Tertiary origin of the granite extending over so large an extent of country, and considered that the views of Richthofen were thus substantiated, and that the present paper would form a starting-point in this field of geology. It showed, moreover, the necessity of combining the observations of the geologist in the field with those of the mineralogist in his laboratory.

Mr. Seeley observed on the importance of this paper as furnishing lines of departure for investigating the early physical history of the earth. He had ascertained that the old lines of volcanic activity corresponded with the agonic lines of magnetism, and the paper afforded data which would assist in drawing conclusions as to the changes in the position of the earth's axis by a comparison of these lines with those of the magnetic currents.

Mr. W. W. Smyth congratulated himself on again hearing of intrusive granitic dykes such as recalled the earlier days of the Society, and tended to dispel some accepted ideas as to metamorphism. He adduced the recent deposits of Etna and Vesuvius in illustration of the specimens exhibited by the author.

Mr. Blanford suggested that there might be in this case only one form of the protrusion of granite. When the gradual passage from stratified rocks into granite could be traced, there could be little doubt of its origin; and even here the granite might be only the result of a very complete metamorphism. He agreed with the author as to the probability of the great horizontal outflows of basalt being subaërial, and not subaqueous, and instanced analogous examples in India.

Mr. Tiddeman, referring to the great length of time alluded to by the author, as represented in the volcanic rocks of Scotland, wished to call attention to the rocks in the neighbourhood of Seuir-na-Gillean in Skye, which consisted partly of basaltic lavas of Miocene age. These appeared to be tilted by the syenite of Marscou, etc., and upon both rested unconformably a great thickness of hypersthene.

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[1] *An abstract of this paper appeared* in the February Number at page 68.

But furthermore, the base of this lastest rock appeared to be thrown down by fault with a displacement of some thousands of feet.

The author, though admitting there were two sides to the question as to th origin of granite, could not regard intrusive masses of granite passing throug rocks of different mineral constitution as the metamorphosed representatives each He briefly replied to the other points raised in the discussion.

3. "Remarks on Fossils from Oberburg, Styria." By A. W Waters, Esq., F.G.S.

The author noticed the limited occurrence of Eocene deposits i Styria, and referred briefly to the researches of Prof. Reuss an Prof. Stur upon them. He then indicated certain species of fossil which he had detected in these beds, adding about nine species t Stur's list.

Discussion.—The Chairman commented on the sad loss which science ha lately sustained in the death of Prof. Reuss, from whose labours he had receive much assistance, and with whom he had long been on the most kindly relation He had been disposed to place these beds as among the Upper Eocene or Oligocen beds, but the discovery of Nummulites in them might cause them to be placed o the lower horizon.

II.—February 4, 1874.—His Grace the Duke of Argyll, K.T F.R.S., President, in the Chair. The following communication were read:—

1. "The Physical History of the Valley of the Rhine." B Prof. A. C. Ramsay, LL.D., V.P.R.S., Vice-President.

The author first described the general physical characters of th valley of the Rhine, and discussed some of the hypotheses whic have been put forward to explain them. His own opinion was th during portions of the Miocene epoch the drainage through th great valley between the Schwarzwald and the Vosges ran from th Devonian hills north of Mainz into the area now occupied by th Miocene rocks of Switzerland. Then after the physical disturl ances which closed the Miocene epoch in these regions the directio of the drainage was reversed, so that after passing through th hill-country between the lake of Constance and Basel, the rive flowed along an elevated plain formed of Miocene deposits, th remains of which still exist at the sides of the valley betwee Basel and Mainz. At the same time the Rhine flowed in a minc valley through the upland country formed of Devonian rocks, whic now constitute the Taunus, the Hundsruck, and the highland lyin towards Bonn, and by the ordinary erosive action of the great rive the gorge was gradually formed and deepened to its present leve In proportion as the gorge deepened, the marly flat Miocene stra of the area between Mainz and Basel were also in great part wor away, leaving the existing plain, which presents a deceptive a pearance of having once been occupied by a great lake.

Discussion.—Mr. Campbell, in illustration of the paper, and of the effec which running water is capable of producing, brought forward some views Daghestán and the Caucasus. Very considerable tracts of this country are drain by cañons, very narrow, but some hundreds of feet in depth; the streams whic pass along them are principally fed by melting snow.

Prof. Hughes doubted the view which referred the present Rhine to any co figuration of the country due to the original level surface of the Miocene while ignored the post-Miocene elevation of the Alps and Jura. He had traced the la from the Forniche Kopf near Andernach down to within 100 feet of the present Rhine. He thought, therefore, that the Rhine began to cut back a channel by rapids and waterfalls from the Rolandseck end at the first appearance of the land above the Miocene sea, and before the close of the earth-movements and volcanic eruptions, which seem to be connected with the later Miocene, but that it took the river so long to eat its way back as far as Bingen that it had time to wind about and form a broad valley in the upper part of its course, that the river continued to run at the higher level at the Bingen end until, at comparatively a far less remote period, the gorge was eaten back through this flat valley; and when once the river had got through the harder rocks near Bingen, it soon disposed of the softer beds in the Mayence basin.

Mr. Koch was inclined to think that the Jura chain had existence in Miocene times, as beds of that age lay horizontally in hollows in the Jurassic rocks. He quite agreed with Prof. Ramsay as to the terraces along the sides of the Rhine gorge.

Mr. Tiddeman did not see the difficulties suggested by Prof. Hughes.

The President remarked that if the physical history of the Rhine were established, it would throw much light on that of other great rivers. He considered the paper of great value, but suggested a doubt whether the history assigned would account for all the phenomena exhibited along the course of the river. There appeared to have been at the commencement of the existence of the river several upheavals of the land, but subsequent to the main upheaval of the Alps. He regarded the channel of the river as entirely due to fluviatile action, but he confessed to having some doubt whether the erosion of the river alone could have effected the enormous amount of denudation exhibited in the district. He inquired whether there was not a possibility of some marine denuding power also having been at work. He also inquired as to the flexure of the rocks and subterranean movements affecting the conditions of the case, especially in connexion with the angles at which the Miocene strata are tilted. A third question alluded to by Prof. Hughes was as to the volcanic action that had gone on in the valley of the Rhine; and he wished to know whether that might not also have conduced towards the present contour of the valley. As to the terraces, he accepted the author's view as correct; but the question still remained as to how far the gorge was due to gradual erosion or to some subterranean action.

Prof. Ramsay, in reply to Mr. Hugh Miller, stated that the detritus brought from the north was found in Switzerland, and that Prof. Sandberger, as he had found out since writing the paper, considered that at the time of its transport the Jura was not in existence. He had conversed with all the principal Swiss geologists; and it was from them he learnt that along what was now a part of the valley of the Rhine a river flowing southwards during episodes in the Miocene period carried pebbles from the north along its course. This river must have dated back even to Eocene times. In reply to Prof. Hughes, he stated that the attribution of the volcanic outflows to Miocene times was very problematical, and that there was great probability of their belonging to a more recent period. Neither did they affect the district mainly under consideration. There was no great succession of terraces, but one main terrace of fluvatile origin, of which extensive traces remained. Similar terraces occurred on the Moselle. In reply to the President, he stated that he did not think that volcanic action had anything to do with the formation of the gorge. The Miocene strata lay in an approximately horizontal direction, and were not tilted in such a manner as to suggest that their absence in the basin was due to any disturbance of the strata. They must, in his view, have been of necessity scooped away by the action of flowing water.

2. "On the Correspondence between some Areas of Apparent Upheaval and the Thickening of Subjacent Beds." By W. Topley, Esq., F.G.S., Geological Survey of England.

The author referred to many instances in which beds have unequal development, being much thicker in some places than in others; and the main object of his paper was to show that such thickening and thinning of beds has an important effect in producing the apparent dip of overlying beds. The thinning of any one bed may have an appreciable effect in producing or increasing its own apparent dip; but where *a whole series of beds thin* constantly in one direction, the amount of the dip of one of the higher beds, due to the *sum of the thinnings of the underlying beds*, is often very considerable.

In illustration of this the author indicated the Lower Jurassic rocks between Leckhampton Hill and Burford. The Inferior Oolite, and the Upper, Middle and Lower Lias thin out rapidly to the east along this line; the base of the Middle Lias is nearly a horizontal line, the easterly "dip" of the Great Oolite being due to the easterly thinning of the Middle and Upper Lias and the Inferior Oolite. The base of the Lower Lias has a *westerly* dip.

It is generally supposed that the dip of any bed is due to great movements of the earth's crust; from the facts mentioned the author argued that our inferences as to such movements will vary according to the beds which happen to be exposed at the surface. In the example given we assume a westerly upheaval because we see the Great Oolite dipping to the east. If over this area the whole of the higher strata had been removed down to the Middle Lias, we should perceive the beds to be flat; if the denudation had exposed the base of the Lias, we should probably suppose that along this line there had been an easterly upheaval.

Under London the entire series of strata between the Palæozoic rocks and the base of the Upper Cretaceous is absent; as we recede from the London Basin the intermediate beds necessarily come in and gradually thicken, producing the dip of the Cretaceous beds towards the London Basin.

The Palæozoic rocks under London are at about 800 feet below sea-level. We now know, by the sub-Wealden boring, that under the centre of the Weald the Palæozoics are also below sea-level. Supposing that they should be found at about the same depth as at Kentish Town, then the Palæozoic floor will be approximately a straight line, whilst we know that the whole of the Wealden and other Cretaceous beds dip to the north, their dip being thus wholly accounted for by the gradual thinning out of all the beds as they approach London. In the case of the Weald, some of the strata are of freshwater origin; we must suppose that the area of water within which they were deposited had some limit to the north, and that the Palæozoic floor, which is now approximately flat, rose up to the north as a bounding ridge. But even if this be so, it is evident that the present dips are no exact measure of the amount of upheaval which the beds have undergone.

Other examples were quoted, in which the observed general dip corresponds in direction with the known or inferred general thinning; and it was shown that in all such cases we are liable to serious error in inferring the amount of upheaval from observed dips.

It is, however, evident, from the faults intersecting strata, that upheavals and disturbances have taken place; but unless we assume every bed to have been deposited on a perfectly horizontal plane, we cannot infer the amount of such upheaval from the present position of the bed. In all cases we must take into account the actual or possible thinning of underlying beds.

The beds which support Geological Basins frequently thin towards the centres of those basins, thus producing, wholly or in part, the basined form of the strata. It was, however, shown that the beds of the basins themselves frequently thicken towards the centre of the basins.

Discussion.—The Rev. O. Fisher remarked that he had always considered that the Palæozoic rocks under London had formed an axis against which the Secondary rocks had abutted, instead of their being carried over the old rocks, as shown in the diagram. He presumed that there would be difficulty in any natural cause constantly leading to the thickening of strata at some particular spot so as to form a ridge in a certain position; and argued that the shattered condition of the flints in some tilted rocks showed that they had been violently upturned.

Mr. Seeley thought the paper extremely suggestive, though possibly its suggestiveness had been carried too far. If the author's views were correct, the sea in which the beds had been deposited must have been of enormous depth, but of this we had no evidence. He could not believe that the chalk or any other sedimentary deposit could in the process of deposition assume such dome-like forms as would be necessary under the author's hypothesis.

Prof. Hughes considered that there were two kinds of thickening, (1) by deposits from a shore line, or (2) by sediment accumulating in a basin. The instances adduced appeared to be the result of the thickening of strata in a basin. He accepted the cautions of the author as to hasty deductions from the dip of strata at the surface.

Mr. Etheridge considered that the Lower Lias was of greater thickness at Burford than supposed by the author.

The Author, in reply, stated that he did not dispute the fact of the Palæozoic rocks being much disturbed and crumpled, nor did he deny that there may have been some disturbance of the upper beds. What he wished to point out was that the disregarding of the fact that strata thickened in certain directions might be and had been a fruitful source of error.

CORRESPONDENCE.

ORIGIN OF THE FLEET.

Sir,—On this subject, in your February number, my friend Mr. Kinahan follows Herschel, Lyell, Bristow, and Whitaker in attributing the heaping of the Chesil bank to "tidal currents."

In your November number for 1869 you did me the honour to publish my opinion, at some length, against these high authorities. May I beg space now for a short repetition?

The Chesil bank is 42 feet above high-water. Shingle does not travel on the high-water surface of a "tidal current," but if it did, how could this current land the shingle 42 feet higher than its own surface? The wind causes the travelling of beach, and I gave this sing-song rule for it—

"As the wind blows, the wave flows;
As the wave flows, the beach goes."

It is not a "tidal current," it is the prevalent south-west wind which throws beaches across the mouths of so many of our streams on the south coast, and which drives them eastward as they enter the sea, and among them all the side streams which fall into and from the Fleet.

The reason of the enormous heaping of the Chesil bank is that the travelling of the beach down the wind is interfered with by the peninsula of Portland, which runs out to sea at right angles to the bank, and acts as a gigantic "natural groin."

It is not only that shingle is now constantly torn down and again landed on the top of the Chesil bank, but a vessel has been heaved bodily over it and into the Fleet. Does Mr. Kinahan think that the vessel floated calmly over the bank on his "tidal current running parallel, or nearly so, to the coast line," or that it was lifted over by the impact given to the wave by a south-west storm?

I wish that I could persuade my friend Mr. Kinahan to read Chapter viii. of "Rain and Rivers" on the "Travelling of Sea-beach," where all this is discussed at length.

Brookwood Park, Alresford, George Greenwood, Colonel.
5th February, 1874.

WELL-SINKING IN THE LINCOLNSHIRE FEN-DISTRICT.

Sir,—I should be very much obliged to any of your readers who could give me information, or references to books where I can obtain it, on the following point:—

At Lincoln the fen, *that extends* along the right bank of the

Witham to Boston, first begins. It occupies a strip between the river on the east and a ridge of Inferior Oolite covered with gravel deposits on the west. The fen is of course thoroughly drained, but is very ill supplied with drinkable water. This is got from dykes which take the water from the oolitic region across the fen and above its level; and is of course at considerable distance from many of the farm houses in the fens.

What probability is there that a bore-hole made through the clays that underlie the fen would tap a good water supply? Is anything known about the thickness of the clay, and the nature of the subjacent strata? I am speaking especially of the fen that lies between Bardney and Nocton, in which I am specially interested.

A farmer there once told me it would be worth fifty pounds to him to get water; and I offered to spend twenty-five pounds on a boring on the condition that if it succeeded he should pay me back. He thought over the suggestion, and could not make it out. Why should I pay *if it failed?* What good could it be to me? He thought there must be something uncanny about it, and he would none of it.

I think of making a boring there in April; and should be truly obliged to any one who will give me information either by private letter, or in the pages of this MAGAZINE.

JAMES M. WILSON.

RUGBY, *Feb. 5th*, 1874.

"DOLMENS" OR "ERRATICS"?

SIR,—I send you a piece, broken off by mischief last November, from a stone standing near the entrance to the bridle-way leading from the top of Southampton Common to Lord's Wood. There are three other similar stones in the neighbourhood. One is about 300 yards off, near Point-house, one in Burgess-street, and one in Lord's Wood. Very likely there are, or at least have been, others. I have known them a long time, and have often been puzzled as to their object. The answer to all inquiries is: "Oh! They are boundary-stones." "Boundary-stones of what?" "Sure, sir, I can't say."

They are nearly square prismatic stones, much weathered—indeed, so much weathered that it was not till this one was broken that I recognized them as Granite. The Granite is fine-grained, light in colour, with a good deal of very black mica.

What are these stones, and where do they come from from?

In the Hartley Museum there are two specimens of rolled greenstone, said to have been discovered on the spot where the Museum now stands.

G. H. WOLLASTON.

CLIFTON, *17th January*, 1874.

ERRATUM.—In the last Number, foot of p. 66, the Rev. O. Fisher ascribes Mr. J. Clifton Ward's paper on Coral Reefs and the Glacial Period to "Popular Science Review" for April, 1873, whereas it appeared in the "Quarterly Journal of Science" for that date.—EDIT. *GEOL. MAG.*

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NEW SERIES. DECADE II. VOL. I.

No. IV.—APRIL, 1874.

ORIGINAL ARTICLES.

I.—The Volcanic History of Ireland.[1]

Being the Anniversary Address delivered to the Royal Geological Society of Ireland, February 11th, 1874.

By Professor Edward Hull, M.A., F.R.S., President;
Director Geological Survey of Ireland.

I HAVE the pleasure of congratulating the Society on its prosperous condition after an existence of forty years, during which time it has numbered amongst its members men of the highest distinction in Science, and has been presided over by some of the most illustrious amongst the cultivators of Geology. In looking over the names of the first officers of the Society in 1833, I am rejoiced to see those of the Provost of Trinity College, Sir R. Griffith, and Professor Apjohn, who are still amongst us; and to myself it could not have been otherwise than a matter of high gratification to have been elected to an office which has been filled by such eminent men as the former Presidents of this Society.

But more honourable to the Society than even the names of its officers are the large number of excellent papers, bearing, though not exclusively, on the Geology of Ireland, which are to be found in the pages of its *Transactions*. It is the merit of the contributions which must stamp the character of a Scientific Society; and amongst all the Geological Societies—that of London only excepted—there is none which has produced so large a number of excellent memoirs.

Other Societies—especially those of Glasgow and Edinburgh—are now treading closely on our heels; and I would, therefore, venture from this chair to urge upon our members a little increase of industry in the preparation of papers founded on observations over various parts of the country. The geological questions and phenomena of Ireland are far from being exhausted, and still present materials for the industrious observer. I would, also, observe, that the arrangements recently effected by the Council with the Editors of the Geological Magazine afford authors of papers read before this Society rare opportunities of extended circulation. By that arrangement, all papers of merit, after having been read before the Society, and approved by the Council, will appear in the pages of the Geological Magazine, and subsequently in those of our *Transac-*

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[1] Plate X., illustrating the Volcanic History of Ireland, will accompany the concluding part of Prof. Hull's Address in the next Number.—Edit. Geol. Mag.

tions; thus guaranteeing to them the advantages of almost a double circulation.

Amongst the papers which have been read during the year 1873–4, I may be allowed specially to mention those of Colonel Meadows Taylor "On the Coal-fields of Central India," that of Dr. Mackloskie "On the Fossil Wood of Lough Neagh," that by Dr. Macalister "On the *Charopsis Hibernicus*," that by Mr. Hardman "On the Occurrence of Zinc in the White Chalk of Tyrone," and by Mr. Meadows "On the Leinster Coal-field"; and I take this opportunity of acknowledging the gift to the Society of a mounted sheet of "Griffith's Geological Map of Ireland," presented by our valued member the Rev. Maxwell Close, F.G.S.

In addressing you this evening, I have ventured to select as my subject, "The Volcanic History of Ireland," but shall preface what I have to say by a few preliminary remarks on the general characters of volcanic phenomena.

The earthquake and volcanic history of individual countries is one full of interest to the physical geologist. This history has been ably written in the case of Scotland by Professor Geikie, and for our own country it seems to be a subject not unsuited to the present occasion. It is, perhaps, less difficult to decipher the characters in which are inscribed the volcanic, than the seismic (or earthquake) history of any special region; for earthquakes, although generally, are not exclusively, confined to volcanic districts, and often pass over without leaving any traces of their action. The existence of faults, or displacements of the strata, are not always to be relied upon as indicating former earthquake action; and owing to the rare cases which have come under actual observation of the production of faults and their connexion with earthquakes, we are not in a position to speak dogmatically regarding their relationship. If volcanic action, during any special geological period, were necessarily connected with, or accompanied by, earthquake movements, and these again with faults in the strata, it would be impossible to account for such cases as the Carboniferous volcanic district of Limerick, in which faults are comparatively rare; or the more recent case of the north-east of Ireland, where most of the lines of fracture are of later date than the consolidation of the great sheets of lava themselves. In a word, whether we regard the Lower Silurian volcanic region of North Wales, so ably illustrated by Sedgwick and Ramsay, the west of Ireland, the Carboniferous volcanic regions of the south of Ireland or centre of Scotland, or the Miocene volcanic districts of the north of Ireland and west of Scotland, we are equally impelled to the conclusion, that the main lines of fracture are totally unconnected with the volcanic products, and belong to periods either preceding, or subsequent to, those of volcanic activity.

In attempting to determine those periods in the past history of our globe in which volcanic phenomena have been prevalent, and the districts in which the products of volcanic action have been *developed, we* must guard ourselves against an error of observation into which we might be liable to fall by observing merely the greater or less proportion of igneous rocks in each case. There may be formations penetrated by numerous sheets and dykes of trap rock, none of which can properly come under the head of "volcanic," and which, therefore, present no true marks of contemporaneous volcanic action. Dykes of trap of an irruptive (or intrusive) character may belong to a geological period different from that of the strata in which the dykes occur; and it is often exceedingly difficult to determine their true age. Even in the case of sheets of trap, unless very careful observations are made regarding their relations to the strata which inclose them, much caution is required in determining the question whether they are volcanic or plutonic, or as the late Professor Jukes used to say, "eruptive or irruptive." While no truly intrusive rocks can be properly called "volcanic," it is clear that all volcanic rocks are to some extent intrusive; for wherever they occur in sheets amongst the sedimentary strata, they must in some part of their extension pass vertically or obliquely through the strata which are in course of formation. Such truly volcanic lavas may therefore present evidences of intrusive action amongst the beds which underlie them; but we may feel sure that the beds which rest upon them, belonging to the same formation, will be not only undisturbed, but remain generally unaltered in physical constitution.

But the most reliable phenomenon to guide the observer in determining the question whether or not true volcanic action has left its traces upon any formation, is the presence of beds of ashes, agglomerates, or other volcanic *ejecta*, which have been blown out of submarine or sub-aerial vents, and have subsequently become interbedded with the strata. For, while it is true that such accumulations may not necessarily be present at all times amongst volcanic rocks of different formations, they are, doubtless, very general accompaniments; and whenever they do occur, we may safely conclude that we are in the presence of truly contemporaneous volcanic rocks; that is to say, rocks which have been ejected in a liquid or fragmental state during the period of deposition of the strata in which they are found.

But, before entering on the consideration of the successive periods of volcanic activity in Ireland, one or two observations regarding the use of the term "volcanic" may not be unnecessary, in order to guard against misconception of my meaning. The term is generally exclusively applied to designate those rocks, consisting of various kinds of lava, ashes, scoriæ, etc., which are now from time to time being poured forth or blown out of active volcanos, or those which, like Auvergne and the Eifel, have become extinct in Post-Tertiary times. We have, therefore, *active* volcanos and *extinct* volcanos, with their respective lavas, etc.; but there seems no good reason why the term should not also be applied to those products of internal igneous action which have been erupted during the formation of Cainozoic, Mesozoic, and Palæozoic rocks, and which are found interstratified with them. And as there are at the present day both subaerial and *submarine volcanos*, so, doubtless, there were in the past;

and geologists are now becoming familiar with such expressions as volcanic rocks of Silurian, Carboniferous or Permian periods, and which, from the necessity of the case, must chiefly be the representatives of the sub-marine or sub-lacustrine classes of volcanos.

Guided, then, by such principles of determination, let us endeavour to review in the order of succession the periods which in this country present us with unquestionable evidences of volcanic activity, and we shall consider them under the three great divisions of geological time, the Palæozoic, the Mesozoic, and the Cainozoic or Tertiary.

Palæozoic Epoch.—The oldest rocks represented in Ireland—the Cambrian beds of the east coast—present us with no evidences of contemporaneous volcanic activity; but when we ascend into those of the Lower Silurian period, we have numerous examples of volcanic rocks in several parts of our island where these formations occur. Throughout the range of these beds in the counties of Wicklow, Wexford, and Waterford, there are numerous sheets of felstones and porphyries accompanied by beds of ash and volcanic breccia, interstratified with the slates and grits which for the most part make up the Lower Silurian rocks of those districts. These contemporaneous traps are referable to the acidic felspathic, or highly silicated felstone group; and amongst them are outbursts of hornblendic rocks, or diorites, as well as a few melaphyres, which are of intrusive origin and later date than the felspathic rocks themselves. The districts of Stradbally and Kill, near Waterford, seem to have been foci of volcanic action. Similar beds of porphyries, felstones, ashes, and agglomerates are of frequent occurrence in the Silurian district north of the valley of the Boyne, but become less frequent in the districts of Down, Armagh, and Cavan. As all the fossils yielded by these Lower Silurian rocks are of marine origin, we must suppose the whole series to be marine; and we may therefore infer, that the volcanic rocks of the period were erupted from vents sporadically breaking out over the sea-bed of the period, and either pouring forth sheets of liquid lava, or vomiting out masses of fragmental materials which were strewn over the bottom, and were in turn covered over by fresh sediment.

It is interesting to observe that these rocks are the representatives of those great sheets of felstone and porphyry which rise into the lofty escarpments of North Wales, and which have been so ably described by Sedgwick, Murchison, and Ramsay; and I am informed that the late Professor Jukes, when engaged with Mr. Du Noyer in mapping out these beds over the Silurian district of the south-east of Ireland, was constantly struck by the marked resemblance of the old volcanic rocks of this district to those with which he had become familiar amongst the mountains of Snowdon, Moel Wynn, and Cader Idris.

Contemporaneous trap-rocks being so abundant amongst the Lower Silurian rocks of the east of Ireland, where they are generally unaltered, it can scarcely be doubted that they are also represented amongst the beds of the same great series in the west and north-west of the island, where they have undergone, for the most part, various degrees of metamorphism. In the Galway district, Mr. Kinahan considers that such rocks may be recognized amongst the hornblende schists of the metamorphosed districts;[1] but while the general conclusion may be admitted, the great amount of alteration which these rocks have undergone, together with their structural complications, renders actual determination in special cases somewhat uncertain.

The Lower Silurian period may, therefore, be considered as having been one of great volcanic activity in this country, as well as in Wales and Cumberland; the products being, for the most part, felspathic and highly silicated, and such as were erupted at various points over the bed of the sea.

Upper Silurian Period.—The Upper Silurian rocks are not very largely represented in our island; nevertheless, they present unmistakable evidences of contemporaneous volcanic action. Nothing can be more conclusive on this head than the phenomena observable in the mountainous region of West Mayo and Galway. Here, on ascending the flanks of Muilrea from the north shore of Killary harbour, we cross over the edges of great beds of grit, slate, and conglomerate, alternating with others of quartz-porphyry, each bed capped by its covering of volcanic ash; as if showing, that after each successive outpouring of lava, there had been a grand eruption of fragmental materials from the volcanic vents. In all probability these vents, like those of the Lower Silurian period, were submarine, nor is there any very marked distinction in the general character of the volcanic products.

Another district of volcanic action of this period is that lying along the western shores of Lough Mask, where beds of felstone, quartz-porphyry, felspathic ashes, and agglomerates are associated with fragmental strata, supposed to belong to the Upper Llandovery series, but which may also represent the earlier stage of the Muilrea volcanic rocks.[2]

The Promontory of Dingle, where it projects into the Atlantic Ocean, together with some of the Blasket Islands, affords evidence of having been another district of volcanic action during the Upper Silurian period. Great beds of ash, agglomerate, and a few of trap form the coast from Clogher Head southwards, for a considerable distance, and again are found at Beginish, Young's, and Inishvickillane Islands, and have been carefully laid down on the maps of the Geological Survey by the late Mr. Du Noyer.[3] The thickness of these volcanic products has been estimated by the late Professor Jukes at 2,500 feet, and they are interstratified with sedimentary strata richly stored with marine fossils of the Wenlock stage. As the beds of felstone and ash of Muilrea probably correspond to this period, we have evidence of at least two centres of volcanic activity in the west of Ireland during the Upper Silurian period, which, for all we know to the contrary, may be but representatives of vastly more extended volcanic regions spreading either beneath the ocean, or beneath formations of more recent age on the land.

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[1] Mem. Geol. Survey, Explanation Sheets, 105 and 114.

[2] See Geological Survey Map, Sheet 85.

[3] Sheet 171. See "Explanation" of Sheets 160, 161, 171, etc., by Messrs. Jukes and Du Noyer, *pp. 12, 46, etc. (1863).*

Old Red Sandstone Period.—The Old Red Sandstone presents us with several examples of contemporaneous volcanic rocks, both in the northern and southern districts. In the neighbourhood of Boyle, in Co. Roscommon, there occurs one or more beds of consolidated ash, interstratified with the red and purple sandstones and conglomerates of that formation.[1] In the southern district, one of the most remarkable and well-known cases is that which occurs amongst the Killarney mountains, south of Lough Guitane, and which has been admirably illustrated by the pen and pencil of Mr. Du Noyer, under the direction of Professor Jukes. Here, at Benaunmore, a bold rock reaching an elevation of 1,490 feet, a mass of columnar felstone indicates the position of an old "neck" or volcanic throat, from either side of which stretch, for considerable distances, beds of felspathic ash and agglomerate, with large "balls" of felstone, often hollow in the centre, which were probably bombs, shot out of the vent at various stages of eruption.° These beds of ash re-occur at Lough Garagarry, Lough Managh, and the Devil's Punch Bowl, to the west of Benaunmore, and rise into the summit of Crohane (2,162 feet), and the southern slopes of Killeen mountain on the east.[2] To the south of this, there is another district containing contemporaneous trap-rocks, forming the cliffs of Cod's Head and Dursey Island, at the mouth of the Kenmare river.[3]

The shores of Lough Kay and Valentia Harbour present to us another striking instance of a volcanic centre of eruption during this period. Beds of greenstone, felstone, ashes, and agglomerates are here associated with those of Old Red Sandstone, and pierced by numerous dykes.[4]

(To be concluded in our next Number.)

II.—On the Tertiary Brachiopoda of Belgium, etc.

By Thomas Davidson, F.R.S., F.G.S.

(PLATES VII. and VIII.)

IN the seventh volume of the Geological Magazine I gave a description, accompanied by illustrations, of all the Brachiopoda then known to me from the Tertiary formations of Italy. I would now offer some notes and figures relative to those that occur in Belgium.

In order to be able to do justice to the subject, Messrs. Dupont and Nyst kindly forwarded me for examination the best examples preserved in the Museum of Brussels, and I am likewise indebted to

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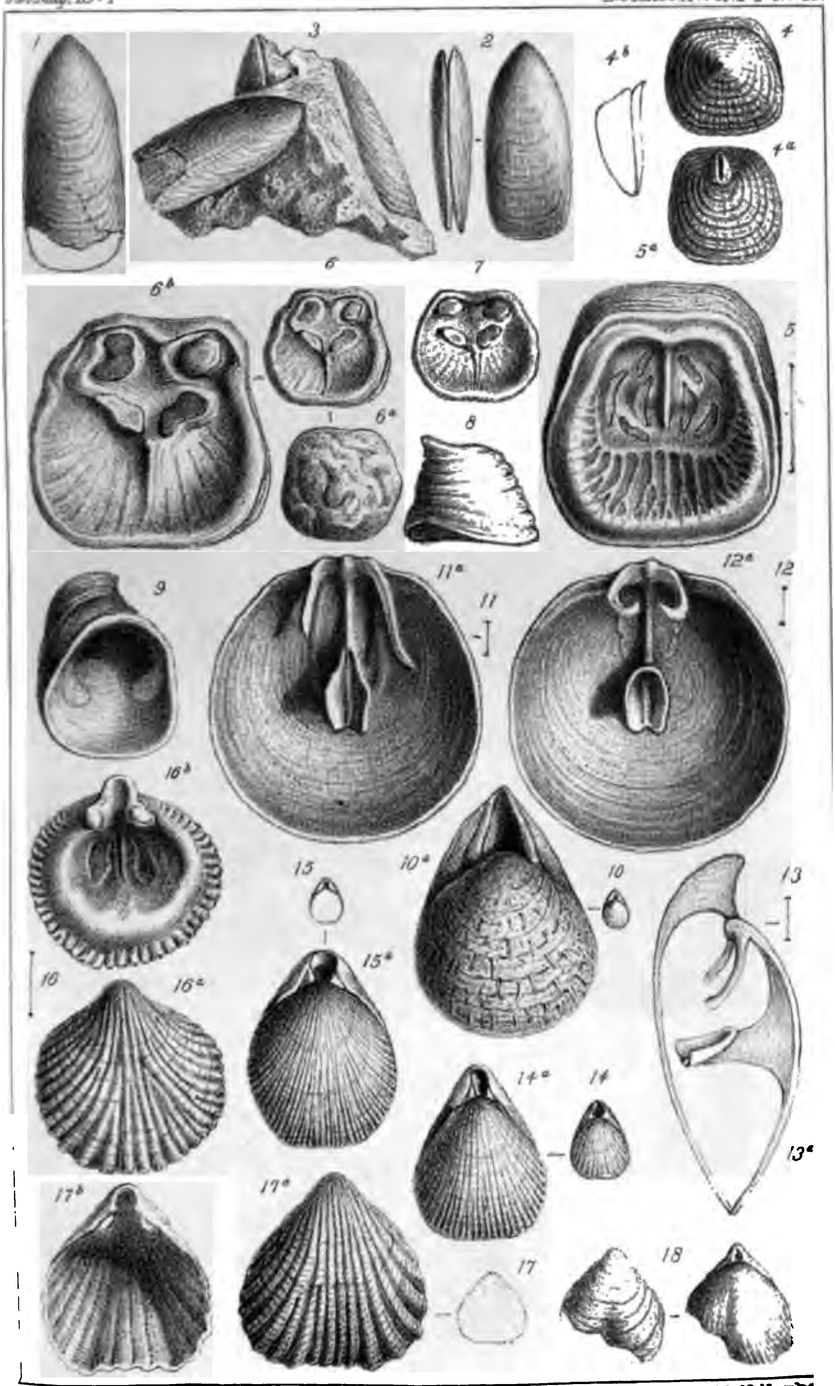
[1] Messrs. Jukes and Foot, Journ. Geol. Soc. Ireland, vol. i. part 3, p. 249.

[2] Maps of the Geological Survey, Sheets 184, 185, with "Explanations."

[3] *Ibid.* Sheet 198, with "Explanations," pp. 8, 17, etc.

[4] *Ibid. Sheet 182, with* "Explanations," p. 26.



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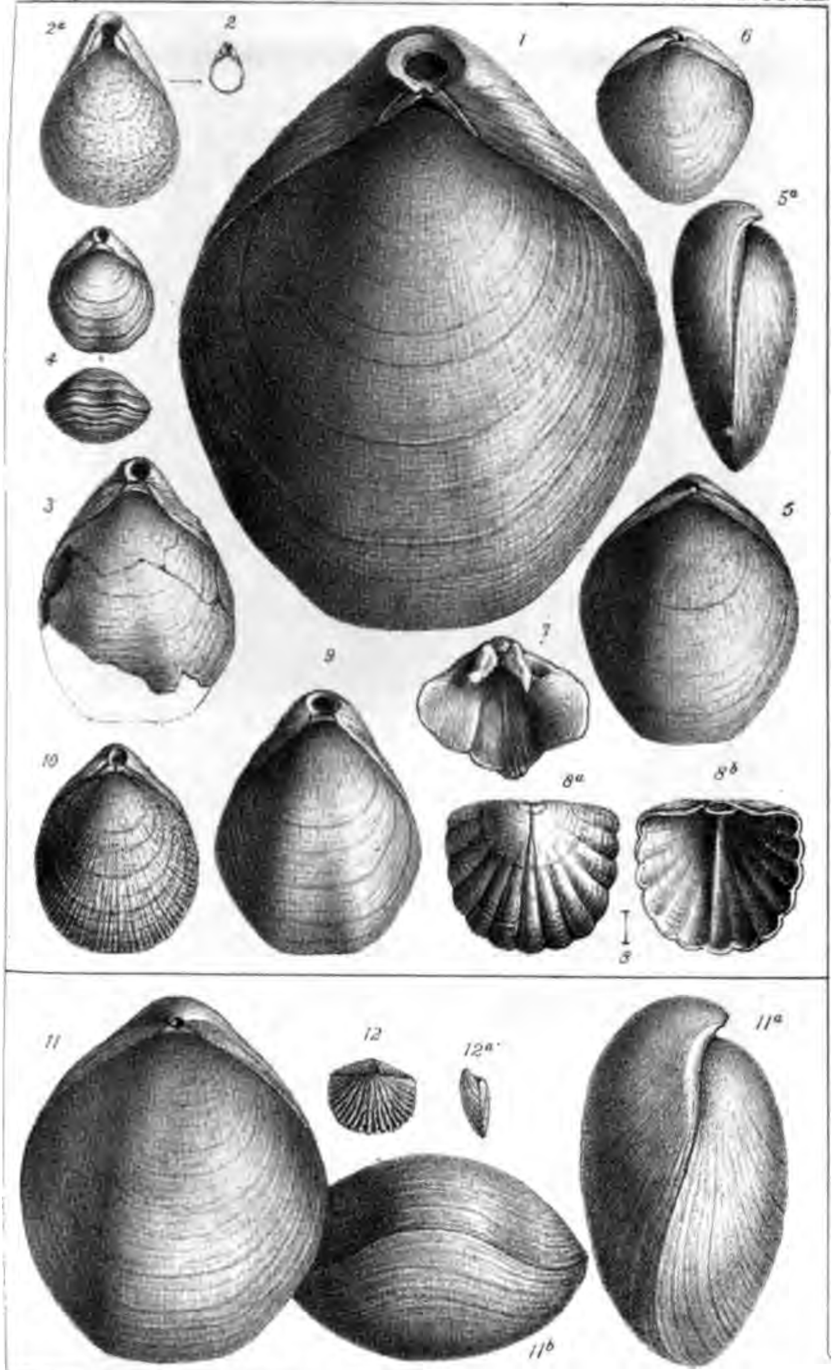
TERTIARY BRACHIOPODA OF BELGIUM



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Figs. 1-10. TERTIARY BRACHIOPODA OF BELG

Messrs. L. de Koninck, Dewalque, Vincent, Lefèvre, and Colbeau for the loan of specimens forming part of their collections.

The Tertiary series is pretty well represented in Belgium, and in his "Rapport Séculaire sur les travaux de la Classe des Sciences de l'Académie Royale de Belgique" (pp. 59-61. 1872) M. Dewalque publishes a table showing the classification of the Tertiary deposits of Belgium, as compared with those of the basins of London and Hampshire.

In 1852 M. Dumont divided the Tertiary formations of Belgium in the following manner:—

PLIOCENE	Système Scaldisien. Système Diestien.	=	our Crag. (The Système Diestien is now considered to be Upper Miocene. T.D.)
MIOCENE	Système Boldérien	=	Faluns of Touraine?
UPPER EOCENE OR LOWER MIOCENE	Système Rupélien	=	Upper Lacustrine deposit and sands of Fontainebleau.
UPPER EOCENE	Système Tongrien	=	Lacustrine deposits of the Isle of Wight.
	Système Laekenien	=	Sands without fossils of Hordwell, also Barton Clay.
MIDDLE EOCENE	Système Bruxellien	=	Calcaire Grossier, Bracklesham Sands, and Bagshot Sand.
	Système Panisélien		
	Système Yprésien	=	Bognor Clay, London Clay.
LOWER EOCENE	Système Landénien	=	Plastic Clay.

CRETACEOUS.

In a letter dated the 2nd of April, 1873, M. Nyst gives me his views relative to the divisions of the Tertiary formations of Belgium, and I have added the names of the Brachiopoda that occur in each of these divisions.

PLIOCENE.

Upper division. Does not exist in Belgium.

Lower division. Composed of yellow and grey sands. The *yellow sands* occupy the upper portion, and are the equivalent of the Crag of Norfolk and Sutton. The *grey sands* should perhaps be considered to represent the Coralline Crag. In this last we find—1. *Lingula Dumortieri*, 2. *Terebratula grandis*, 3. *Terebratulina caput-serpentis*, 4. *Rhynchonella Nysti*, and 5. *Rh. psittacea*?

MIOCENE=Système *Diestien* of Dumont.

The *upper portion* is composed of the black sands (sables noir) of Diest, and of Antwerp. This deposit seems to be wanting in Great Britain. It contains the *Mannia Nysti* of Dewalque.

The *lower division* of the Miocene formation is represented in England by the marls of Henis in the Isle of Wight, and in which fresh and brackish-water shells abound. It contains no Brachiopoda. The sands of Lethen and of Hoesfelt have hitherto afforded no other species of Brachiopoda besides the *Discina Suessi* and *Terebratulina ornata.* M. Nyst believes this last named bed to represent the Barton Clay of England.

EOCENE.

The *upper division* of the Eocene formation is wanting in Belgium.

The *Middle Eocene* is composed of the sands of Laeken, with *Nummulites planulata, var. minor.* It is the equivalent of the Bracklesham sands, as well as of the "Sables Moyens" of France. In this formation the only Brachiopod hitherto discovered is the *Argiope Lefèvrei*. Geologists have attributed to the *Lower portion* of this division the sands of Lede near Alost, and which contain the *Nummulites Heberti* (*N. variolata*). Here also is found the *Terebratula Kicksii*, *T. bisinuata*, *Terebratulina Putoni*, and *Crania Nysti*. This formation occurs at Dieghem, Jette, and probably likewise at Gand. It seems to be present at Mount Cassel near Lille, and where *Terebratula Kicksii* has been collected by M. Nyst, myself, and others, although M. Deshayes makes no allusion to it in his magnificent work.

To the *lower division* M. Nyst refers the beds of Chercq, near Tournay, where a *Terebratula* and a *Terebratulina* (Pl. VIII. Figs. 9 and 10) have been found, and which he thinks would correspond to the Thanet sand, and in France to the Sables de Bracheux.

In his publications on the Tertiary deposits of Belgium, M. Dewalque gives the name of Bruxellien Supérieur to the "Laekenien Inférieur" of Dumont and Nyst: they represent the same horizon.[1]

I regret to say that I am not yet sufficiently well acquainted with the Tertiary species of Germany to be able to treat them as I have done those from Belgium.

Dr. C. M. Wiechmann, of Mechlenburg, has, however, furnished me with the following list:—

LOWER.—Etage oligocène = Système Tongrien inférieur.

Terebratula grandis, Blumb. Latdorf, near to Bernburg, Helmstadt, and Brandhorst, near Bünd (Westphalia).

Terebratulina lattorfensis, Giebel. Latdorf.

Terebratulina striatula. Helmstädt and the neighbourhood of Magdeburg.

Terebratulina ornata, Giebel (*T. Nysti*, Bosquet). Helmstädt, Latdorf, Unseburg, Atyendorf, Westergeln, Osterweddingen.

Argiope multicostata, Bosquet (=*plana*, Giebel). Latdorf.

Thecidium Mediterraneum, Risso, var. *Latdorfensis*, Dav. Latdorf.

MIDDLE.—Etage oligocène = Système Tongrien supérieur and rupélien (Dumont).

Terebratula grandis, Blum. (= *T. subrhomboidea*, Speyer). Neustadt, Magdeburg, Söllingen (Hanover).

Terebratula opercularis, Sandb. Basin of Mayence, Waldbörkelheim. Prof. Koenen unites this species with *T. grandis*.

Terebratulina fasciculata, Sandb. Basin of Mayence, Waldbörkelheim. This species is very nearly related to the *T. ornata* of Giebel.

Argiope subradiata, Sandb. Basin of Mayence, Waldbörkelheim.

Argiope crenata, Sandb. Basin of Mayence, Waldbörkelheim.

Argiope megacephala, Sandb. Same locality.

UPPER.—Oligocène. Basin of Cassel, Sands of Doberg, near Bünde, of Crefeld, of Wiepke, Limestone of Sternberg.

Terebratula grandis. Doberg, near to Bünde (Westphalia), Astrupp, near Osnabrück, basin of Cassel, Wiepke.

Terebratulina subpulchella, v. Münst. Astrupp.

Platidia pusilla, Phil. (Tereb.) Basin of Cassel, Crefeld.

In the Miocene Sands (Système Diestien) of Germany we find only the *Tereb. grandis*. Herr Fuchs, Curator of the Imperial Museum of Vienna, has furnished Dr. C. M. Wiechmann with the following list of Brachiopoda from the Tertiary formations of Austria, and of which a monograph is expected from the able pen of Prof. Suess :—

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[1] An instructive paper, entitled "Note sur la Faune Laekenienne Supérieur des environs de Bruxelles," has been recently published by MM. Lefèvre and G. Vincent. 1873.

Three new species of *Terebratula*, one of *Terebratulina*, *Megeilea truncata* (*oblita*, Michelotti) : *Platidia Anomioides*, Scacchi sp., *Argiope decollata*, Chemn., *A. Neapolitana*, Scacchi, *A. squamosa*, Eichwald, and a new species. Also a new species of *Crania* and of *Lingula*.

Very few Tertiary Brachiopoda are recorded from Russia.

Belgian Species.

1. *Lingula Dumortieri*, Nyst, Pl. VII. Figs. 1, 2, 3.

Nyst, Coq. et Polyp. Tert. de la Belgique, p. 337, pl. xxxiv. fig. 4. 1843.

Large examples of this fine *Lingula* have been found in the Assise Scaldisien, sables gaunes (crag), at Stenyvenberg, near Antwerp. It is, however, very rarely obtained entire. The best examples hitherto collected are preserved in the Museum of Brussels.

2. *Discina Nysti*, Pl. VII. Figs. 4, 5.

Bosquet, Notice sur deux nouveaux Brachiopodes trouvés dans le Terrain Oligocène du Limbourg Néerlandais et du Limbourg Belge, Comptes rendus de l'Académie Royale de Belgique, vol. xiv. pl. 1-5. 1862.

This interesting species has been very minutely described and illustrated by M. Bosquet. It occurs in a deposit attributed to the Middle Oligocene at Elsloo, a locality situated at the distance of about a hundred steps from the Belgian frontier. It cannot, strictly speaking, be considered a Belgian species, as no example has been hitherto picked up on Belgian soil; but as its locality is so near to the Belgian frontier, we have deemed it desirable to record its presence.

3. *CRANIA NYSTI*, n. sp. (?), Pl. VII. Figs. 6, 7.

Crania Hoeninghausi, Dav., Quart. Journ. Geol. Soc. vol. viii. p. 339, pl. xviii. fig. 8, August, 1852.

Crania (*Pileopsis*) *variabilis*, Nyst and Dewalque, Prodrome d'une description Géologique de la Belgique, p. 407. 1868. (Not *Pileopsis variabilis* of Galeotti.—T.D.)

"Shell irregular, inæquivalve, transversely oval, slightly conical, patelliform, depressed: vertex almost central: surface exteriorly unequal and rugose. Interior of upper valve (the only one known) concave, margin narrow, granulated. Four muscular impressions: the posterior ones are more or less circular, lying close to the inner edge of the granulated margin, and separated from each other by a flat space not equal in size to one of the muscular impressions; the anterior pair are irregularly oval, diverging from near the centre towards the posterior lateral margin: a slight prominence existing before the central pair. Vascular impressions not well defined, structure punctuated."[1] Length 7, width 9 lines.

In 1852 Sir C. Lyell placed in my hands for description and illustration the unattached valve of a *Crania* he had obtained from the Eocene beds of Dieghem, near Brussels. On comparing this valve with others of the *C. Hoeninghausi* of Michelotti and which occur

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[1] *Quart. Journ. Geol. Soc. vol.* viii. p. 339, pl. xviii. fig. 8. 1852.

This species (?) has been well described by the two palæontologists above named. It seems, however, to differ very little from *Terebratulina striatula*. A single specimen was found by M. Colbeau in the "Laekenien" of Dieghem, near Brussels. It occurs abundantly in the Calcaire Grossier at Parnes, Mouchy, and Chaussy in France.

9. *Terebratulina ornata*, Giebel, Pl. VII. Fig. 16.

T. ornata, Giebel, Jahrbuch für Mineralogie, 1847. *T. Nysti*, Bosquet, Notice sur deux nouveaux Brachiopodes, Acad. Royale des Sciences, vol. xiv. pl. vi. 1862.

This species has been described and figured by M. Bosquet from a single dorsal valve, found by himself in the lowest bed of the Oligocene formation at Hoesfelt, in the Belgian Limbourg; but he informs me by a letter, dated the 26th of April, 1863, that a short time after his publication he was able to obtain two examples of the *Terebratulina ornata* of Giebel, the one from Latdorf, the other from Westergeln, and that it was then only that he recognized that his *T. Nysti* was the same species.

10. *Argiope Lefevrei*, Nyst, Pl. VIII. Fig. 8.

Described by M. Nyst in M. Th. Lefèvre and G. Vincent's paper on the Upper Laekenien fauna of the neighbourhood of Brussels, p. 20, pl. iii. figs. 7, 8. 1873.

Of this small species a single dorsal valve has been found by M. Lefèvre in the Lower Zone of the Upper Laekenien formation (=Boulder-Clay) of Laeken, in Belgium. It belongs to the division *Cistella*, Gray, and which was created for the reception of those species with a single median submarginal septum and bilobed loop.

11. *Mannia Nysti*, Dewalque, Pl. VII. Figs. 10 to 13.

Dewalque, Prodrome d'une Description Géologique de la Belgique, p. 432. 1868.

Shell small, triangular, longer than wide, broadly rounded anteriorly, tapering to an acute termination posteriorly. Dorsal valve moderately convex, ventral valve slightly deeper than the opposite one, without sinus or fold. Beak produced, nearly straight, or very slightly incurved at its extremity, and a little less than a fifth of the length of the shell. Fissure triangular, large and margined laterally by two narrow deltidial plates, commencing under the angular extremity of the beak. External surface of both valves marked by concentric scaly lines of growth, from which scattered adpressed spinules seem to rise. Shell-structure fibrous, no perforations or canals being observable. Length two lines, by one and a half in breadth, and half a line in depth. Owing to the smallness and brittle condition of the shell, it has not been hitherto possible to obtain a perfect interior of the dorsal valve. We cannot, therefore, give of it a complete diagnosis, but will describe and illustrate what we know of it.

In the interior of the dorsal valve a small cardinal process occupies the centre of the hinge-plate. From the inner portion of this plate *extend two slender* longish lamellæ (Fig. 11); but as their anterior terminations are broken, we cannot say whether or not they became attached to the central vertical septum. Two small curved crura project also from the above described lamellæ, as seen in Fig. 12. From under the middle of the hinge-plate a small ridge extends along the bottom of the valve to about half the length of the shell, and which, as it nears the middle of the valve, forms a high triangular-shaped vertical plate, almost perpendicular in front. To each side of the slanting top, and facing the hinge-plate, are two small triangular plates united posteriorly, separate and angular anteriorly. Large muscular impressions are also observable on either side of the bottom of the valve, close to the vertical septum (Fig. 11). In the interior of the ventral valve two strong teeth project from the base of the fissure, and a narrow vertical plate divides the larger portion of the beak into two portions.

M. Dewalque did not describe or illustrate his genus and species, he simply gave it the name of *Mannia*, and has requested me to point out its characters; but this cannot be done satisfactorily until we are in possession of a specimen showing the complete interior of the dorsal valve.

About thirty specimens of this small species were collected by M. Dewalque from the top of the Miocene beds (Sables Noir du Système Diestien), at three miles east of Antwerp.

12. *Rhynchonella Nysti*, n. sp., Pl. VII. Fig. 17.

Of this interesting species two ventral valves only were found by M. Nyst in the "Scaldisien" "sables gris" (Crag) of Antwerp. We cannot therefore give a complete description of the shell. These valves are triangular in shape, and measure from four lines in length to something less in breadth. Under the angular beak may be seen a foramen with two narrow labial deltidial plates. . The mesial sinus occupies about one-third of the breadth of the shell, and commences at a short distance from the beak. About seventeen strong angular ribs cover its surface, and of these some few bifurcate. The surface is also crossed by equidistant scabrose projecting lines of growth. In external shape and character it approaches to some recent examples of *Rh. nigricans*.

13. *Rhynchonella psittacea*, Linné (?), Pl. VII. Fig. 18.

Two incomplete and worn valves of a *Rhynchonella* here, with some uncertainty, referred to *R. psittacea*, were found by M. Nyst in the étage Scaldisien "Sables Gris" (Crag) of Antwerp. Their almost smooth surface, and absence of the fine radiating striæ peculiar to *R. psittacea*, render their identification uncertain. They approach also in shape and character to some examples of *Rh. bipartita* of Brocchi, as well as to the recent *Rh. lucida* of Gould.

In addition to the thirteen Belgian Tertiary species above enumerated, M. Nyst sent me for examination two other forms (Pl. VIII. Figs. 9, 10), which he states to have been derived from the Assise Landénien (= Plastic Clay) of Chercq, near Tournay. To one of them, Fig. 10, he gives the MS. name of *Terebratulina Woodi.* The other is a *Terebratula,* bearing much resemblance to certain forms of which, so far as I am aware, presents even a superficial resemb to *Botryllopora*, is *Evactinopora*, Meek and Worthen. In this genus, however, though the polyzoary is star-shaped, its int structure is quite peculiar and altogether different from that former, whilst the entire organism appears to have been free.

The individual discs of *Botryllopora*, which, though social, ar organically united, present, on the other hand, a striking r blance to the separate star-shaped elevations of *Stellipora* (*Cc laria*) *Antheloidea*, Hall, from the Lower Silurian; and it therefore, be proper to say a few words on the structure and affi of this fossil, of which I have examined authentic speci *Stellipora antheloidea* occurs in the form of flattened expansio of erect, flattened, sub-palmate fronds. The surface exhibits number of little star-shaped elevations, each about a line in dian and consisting of a smooth, sometimes slightly depressed space, is traversed by five or six obtusely-rounded radiating ridges, do not quite meet in the centre. Each of the ridges of the s covered with rounded calices irregularly disposed in three o rows. The stars are arranged irregularly, generally at interv from half a line to a line; and the intervals between the occupied by crowded circular pores, which are the mouths many tubuli. These pores do not encroach upon the spaces bet the ridges of the stars, and the tubuli of which they are the m are seen on transverse section to be *tabulate*, being furnished numerous distinct transverse partitions. It thus appears that *S pora antheloidea*, Hall, is not a Polyzoon, as believed by D'Orb but, as pointed out by Milne Edwards and Haime, a *tabulate* allied to *Monticulipora*, and presenting in particular a close r blance to the coral which I have described under the nan *Callopora incrassata*.

BOTRYLLOPORA SOCIALIS, Nicholson. Pl. IX. Fig. 16.

Polyzoary social, consisting of systems of calcareous discs v are adherent by their lower surface to the exterior of foreign b and which are not organically connected with one another. The surface of each disc approximately convex, but with a centra pression or flattened space, surrounded by a series of strong o elevated ridges arranged in a radiating manner. The diamet the discs is about a line or a line and a half, and the radiating r are from eighteen to twenty-six, or more, in number. The r are unequally developed, some extending nearer to the centre others, and each carries upon its upper surface a double ro minute round pores or apertures, the margins of which ar elevated above the general surface. The central space of the zoary is destitute of cells, and appears to be solid; and this s also generally to be the case with the spaces between the radi ridges. In some cases, however, the interradial spaces appear poriferous in the immediate vicinity of the circumference.

The groups of this singular *Polyzoon* are not of very rare o rence in the Hamilton Formation, growing parasitically upo

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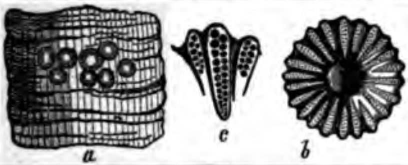

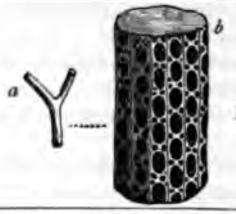

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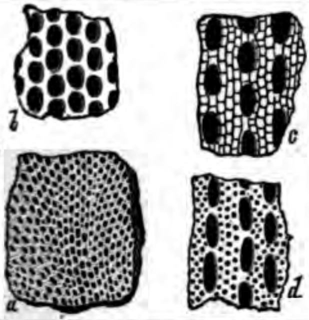

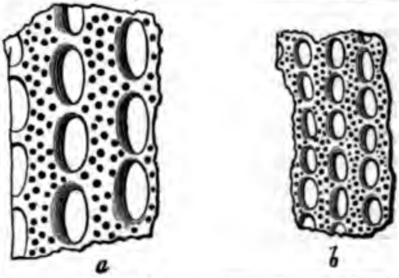

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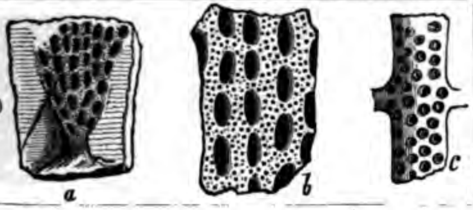

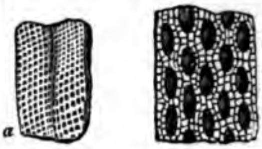

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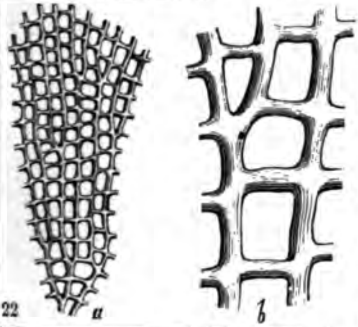

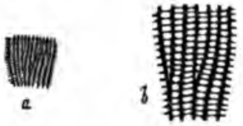

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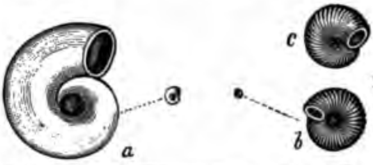

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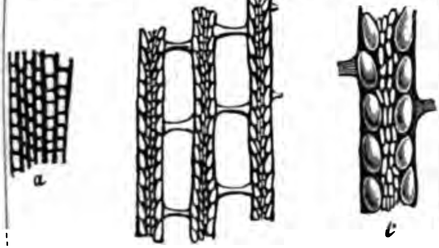

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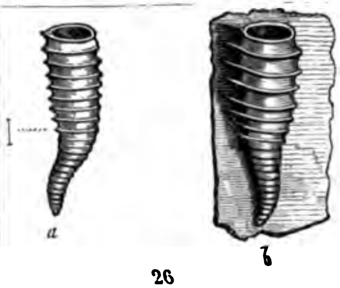

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To illustrate Prof. H. A. Nicholson's paper on New Devonian Fossils.

exterior of *Heliophyllum Halli.* It has, at first sight, a close resemblance to a group of little discoid corals, such as *Microcyclus*, attached by the whole of the lower surface; the radiating ridges looking like the septa, and the central space representing the calice. I do not know of any Palæozoic forms of *Polyzoa* with which the present species could be compared; and it is readily separated from such forms as *Defrancia* by the entirely different characters of the cells, which approach closely in form to those of *Retepora*, *Fenestella*, and *Polypora*. The largest group that has come under my notice comprises about twenty of the discoid cœnœcia, mostly in contact, but apparently in no way connected with one another directly.

Locality and Formation.—Hamilton Formation, Bartlett's Mills, near Arkona, Bosanquet.

CERIOPORA (?) HAMILTONENSIS, Nicholson. Pl. IX. Fig. 17.

Polyzoary ramose; branches cylindrical, about half a line in diameter, dividing dichotomously at intervals of from a line and a half to three lines, the angle included between each pair of branches being from 40° to 45°. Surface covered with oval, rounded, or subquadrate cell-mouths, arranged in longitudinal rows, which are separated by delicate thread-like lines or ridges. The cells of contiguous rows alternate, so that the apertures come to be also disposed in regular diagonal lines. About four rows (sometimes five) occupy the width of the stems, the cells having a width of about a tenth of a line. About five cells occupy the space of one line measured vertically. The interspaces between the mouths of the cells are occupied by exceedingly minute tubuli, which form only a single row, or are altogether absent on the lines which bound the cells laterally, whilst they usually form a double series on the spaces by which the cells of a given row are separated vertically.

This beautiful little fossil occurs in great abundance in some of the beds of the Hamilton formation. It is allied to the *Ceriopora punctata* of Goldfuss (Petref. Germ. plate lxiv. fig. 12), and to *Millepora interporosa*, Phillips (Geology of Yorkshire, vol. ii. pl. i. figs. 36–39), especially to the former; but it is distinguished from both by perfectly good and easily recognized characters. I am at present unable to decide as to its true generic affinities, and have simply referred it provisionally to *Ceriopora* on account of its close relationship to *C. punctata*, Goldf., which likewise occurs in the Devonian Rocks.

Locality and Formation.—Common in the Hamilton Formation, Widder, Township of Bosanquet.

POLYPORA PULCHELLA, Nicholson. Pl. IX. Fig. 18.

Polyzoary infundibuliform or flabellate, often of considerable size. Branches nearly straight, radiating from the base, and increasing in number by bifurcation at intervals of from two to four lines. About six branches in the space of three lines, the diameter of the branches being rather more than a quarter of a line, and the interspaces slightly less. Dissepiments on the same plane as the outer surface of the polyzoary, depressed below the inner surface, short, narrower than the branches, and placed at intervals of about half a line Fenestrules regularly oval, half a line in length, and about a q of a line in width, four or five in the space of three lines, alt or sub-alternate in contiguous rows. The upper or inner surf the branches carries the cells, three rows of which occur on branch, and sometimes four opposite the origin of the dissepi The cells are flask-shaped, sometimes slightly unequal in size, mouths round, those of the central row alternating with those lateral rows. From six to eight pores in the space of a line, or to four in the length of each fenestrule. The reverse face polyzoary is smooth or obscurely striated.

The species to which this is most nearly allied is *P. Hal* Prout, which occurs in the St. Louis Group of Illinois, and I have likewise detected in the Corniferous formation of O *P. pulchella* is, however, readily distinguished by the greater de ment of the dissepiments, the greater proportionate and ab width of the fenestrules, and the possession of three (instead of rows of cells on each branch.

Locality and Formation.—Common in the Corniferous Lim of Port Colborne, and Lot 6, Con. 1, Wainfleet.

POLYPORA TENELLA, Nicholson. Pl. IX. Fig. 19, *b*.

Polyzoary small, forming a flattened expansion; branches r ing from the base, and increasing by bifurcation at interv about two lines. Branches narrow, about eight in the space of lines, their width being about a quarter of a line. Fenestrules about eight or nine in a space of three lines measured longitudi and ten in the same space measured diagonally; the length o about half a line, the width a third less. Dissepiments very and narrow, without pores. Cells arranged in three alter rows on the branches, opening by minute rounded apertures or three of which occupy the length of a fenestrule. Revers known.

This pretty little species is nearly allied to *P. pulchella* a *Halliana*; but is distinguished by its much more delicate p tions, its narrower and more closely-set branches, and its s fenestrules.

Locality and Formation.—Rare in the Corniferous Lime Lot 6, Con. 1, Wainfleet.

POLYPORA TUBERCULATA, Nicholson. Pl. IX. Fig. 20.

Polyzoary small, forming a flattened expansion, which s from a strong foot-stalk. Branches radiating from the bas increasing by bifurcation at intervals of about a line and a from a third to half a line in breadth, rounded and destit carinæ. Dissepiments very short, widest at their junction the branches. Fenestrules somewhat irregular in shape, u a very long oval, always longer by from one-half to two-third wide; having an average width of a third of a line to half a li a length of one line or a little less. Two fenestrules in the sp *two lines measured* longitudinally, four in the same space me transversely; those of contiguous rows being usually opposite or nearly so. Dissepiments non-poriferous. Four (sometimes three) alternating rows of cells on each branch, opening by minute rounded pores, which are prominently elevated above the general surface. Five pores to the length of a fenestrule. Reverse unknown.

Polypora tuberculata differs from all the other recorded species of the genus, except *P. verrucosa*, McCoy, in the possession of prominent-edged pores, which give to the celluliferous surface of the branches a peculiar tuberculated or pustulose appearance. The latter species, however, has exceedingly long and narrow fenestrules, with nearly twice as many pores to the length of a fenestrule. I have only seen fragmentary examples of this species.

Locality and Formation.—Rare in the Hamilton Group, Bartlett's Mills, near Arkona, Township of Bosanquet.

RETEPORA PHILLIPSI, Nicholson. Pl. IX. Fig. 21.

Polyzoary infundibuliform, or forming a flattened expansion. Branches slender, fifteen to eighteen in a quarter of an inch measured transversely, parallel, flexuous, not united by dissepiments, but coalescing at intervals of about a third of a line, and over spaces of the same length. Fenestrules oval, six or seven in the space of a quarter of an inch measured vertically, seven or eight in the same space measured diagonally (five in two lines on an average), regularly alternate in contiguous rows. Cells in two alternating rows upon each branch, the rows separated in decorticated specimens by a distinct impressed line. Three cells to the length of a fenestrule, sometimes only two; and one or two opposite the points where the branches coalesce. Reverse unknown.

This is a genuine *Retepora*, and in its general form and its biserial cells is closely allied to *R. prisca*, Goldfuss, which I have found abundantly in the Corniferous Limestone of Ontario. It is, however, readily distinguished by the more slender, rounded, and apparently non-angulated branches, the much smaller size of the fenestrules, and the greater number of these openings in a given space. I have named the species in honour of Professor Phillips, to whom we owe so many descriptions of Devonian and Carboniferous fossils.

Locality and Formation.—Corniferous Limestone, Port Colborne.

(To be concluded in our next Number.)

⁂ Plate IX. will accompany the concluding part of this paper in our next Number. —EDIT. GEOL. MAG.

IV.—*HYBODUS*, A COAL MEASURE FISH.

By W. J. BARKAS, L.R.C.P. Lond.; M.R.C.S. Eng.

THERE appear to be two or three obstacles in the way of a proper classification of fossil fishes, and of obtaining sufficient data to establish the earliest period of the earth's formation, during the deposition of which any particular fish existed, the principal obstruction being caused by the disconnected manner in which the researches have been carried on; for palæontologists, as a rule, confine themselves to the fauna or flora of the formations that are most expo in their localities, either by nature or by the hand of man. T palæontologists, living in a district where the extraction of Coa the chief employment, collect and study the remains existing in Carboniferous strata, and often their researches are narrower e than this, being confined either to the true Coal Measures or to Subcarboniferous Limestones. In consequence of this limitation inquiry, there is often great ignorance of what passes in distr where other formations are worked, and it may very well hap that the remains of the same fish or reptile may be found in ferent formations, but yet be named differently and considered distinct genera. Errors also arise from collectors following dogmatic statement of some distinguished palæontologist. In manner, Prof. Owen caused great confusion among Coal Meas inquirers when he published his "Dental Characteristics of Fish for in that work he founded numerous new genera upon very sn data indeed. The confusion in this case, however, was not of l duration; for Messrs. Hancock and Atthey (the latter having proba the largest collection of Coal Measure Vertebrate remains in Northumbrian district) immediately showed most conclusively, fr specimens in their possession, that every tooth named by P Owen had either been named previously, and of course differen or was simply a tubercle, and not a tooth. I also can emphatic confirm their conclusions. In the same manner I consider the st ment of the late Prof. Agassiz, that the fish *Hybodus* was ne found below strata of Triassic age, while its ally *Cladodus* existed the Carboniferous period, has influenced palæontologists to beli that all teeth having the characters of *Hybodus*, and found in Coal Measures, could not be *Hybodus*, but *Cladodus*. The be that the remains of the former fish are never found in the C formation has hitherto been universal; yet I have seen specim gathered in Northumberland and Staffordshire that cannot be tinguished in any way from the descriptions and drawings given Agassiz in his excellent work "Poissons Fossiles." In fact tha the only work, combining both *Hybodus* and *Cladodus*, that I h access to, in which I can find any definite descriptions or drawin and these are so good that I cannot do better than quote his wo and copy his drawings in order to prove that remains of *Hybodus* found in the Coal Measures. In the second volume of the "G logical Survey of Illinois" there are excellent descriptions engravings of *Cladodus*.

In the third volume of the "Poissons Fossiles" Agassiz says, w regard to the geological position of *Hybodus*, "Nous voyons des de d'*Hybodes* apparaître pour le première fois dans le Muschelkalk, continuer dans le Keuper, et devenir très-nombreuses dans le L et dans les terrains inférieur du Jura. Il n'y a que la craie qui nous ait pas fourni de dent qu'on puisse rapporter au rayon d craie de Lewis, que j'ai décrit sous le nom de *Hybodus* sulcat Enfin les *Hybodes* sont complètement étrangers aux terrains tertiai *et à l'epoque actuelle*, qui ne contiennent ni rayons ni dents de

type." Again, as to the position of *Cladodus*, he remarks, "Toutes les espèces comme jusqu'à ce jour proviennent des terraines houillers." In the catalogue of the collection of fossils in the Museum of Practical Geology, I notice there are not any *Hybodi* mentioned as having been obtained from formations below the Lower Lias, and all their *Cladodi* have been discovered in the Carboniferous Limestone, and not in the true Coal Measures. The specimens of *Cladodus* described in the second volume of the "Geological Survey of Illinois" were obtained both from the Coal Measures and from the Subcarboniferous Limestone, but principally from the latter. The true Coal Measures have supplied the *Cladodi* in my possession, and all that I have observed in the collections of other local palæontologists.

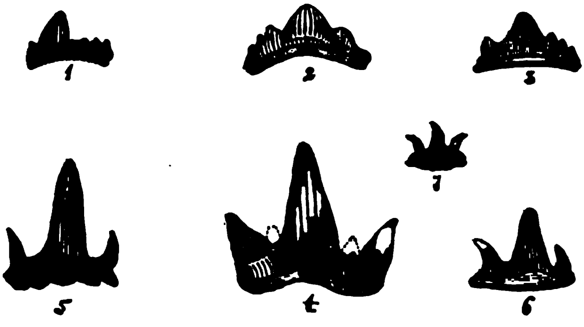
Before remarking upon the teeth of *Hybodus* and *Cladodus* that have been obtained from the true Coal Measures in the Northumbrian and other districts, I shall quote the description of those teeth as given by Agassiz, and shall then direct attention to a few of his engravings of the teeth for the purpose of immediate comparison with the drawings of teeth that have been found in the Coal Measures and wrongly named *Cladodus*, and also with specimens of true *Cladodus* obtained from the same Measures. The teeth of *Hybodus* are "En général plutôt grèles que massives, ces dents se caracterisent par la présence d'un cône médian ordinairement sensiblement allongé, subulé et pointu. Ce cône, qui, dans beaucoup d'espèces, est aussi long et même plus long que la base de la dent sur laquelle il repose, est flanqué, des deux côtés d'un certain nombre de petits cônes que nous appelons cônes secondaires, et *qui vont en decroissant du milieu vers les bords*, de telle manière que la plus grand est aussi le plus rapproché du cône principal et que le plus petit en est le plus éloigné. *Le nombre de ces cônes secondaires n'est pas toujours égal des deux côtés de la dent*; tantôt ce sont les antérieurs, tantôt les postérieurs, qui sont les plus nombreuse et les plus développés. Jusqu'ici je n'en ai pas remarqué plus de *quatre* d'un côté, mais souvent il n'y en a qu'un ou deux. . . . Le cône principal est plus ou moins comprimé de dehors en dedans, ... cet aplatissement ne va jamais jusqu'à rendre la externe face de la dent tout-à-fait plate ou même concave. . . . Toute la surface de la dent est couvert de plis verticaux, plus ou moins gros, suivant les espèces, mais en général très-distincts, . . . c'est toujours à la base de l'émail que les plis sont le plus accusés. . . . La racine de la dent est grosse et osseuse. . . . La racine est en général parallèle à la base de l'émail.

After describing the different species of *Hybodus*, he proceeds to give the characteristics of *Cladodus*, "*Les dents de ce genre ont la plus grande ressemblance avec celles du genre Hybodus.* C'est la même forme élancée du cône médian; le même aspect plissé de l'émail; les mêmes rapports entre la racine et la couronne. *Le cône principal est également flanqué de chaque côté de cônes secondaires*, mais avec cette différence qu'au lieu d'aller en *décroissant* du milieu vers les bords, ces cônes secondaires *présentent* une disposition inverse, c'est-à-dire que la cône secondaire externe est sensiblement plus developpé que les autres."

According to Agassiz, then, the only external differences between *Hybodus* and *Cladodus* are, that in the former the secondary denticles *decrease* in size as they proceed from the centre, while in the latter they *increase*; and also that in *Hybodus* the secondary denticles are *unequal* in number on each side of the principal cone, while in *Cladodus* they are *equal* on each side of the centre denticle.

With regard to the microscopical structure of these teeth, the above is the only author that I am acquainted with who has described it, and he says, "Les dents du genre *Cladodus* montrent en général la même structure fondamentale que celles des *Hybodes*;" but he considers that in the former teeth the medullary canals are larger and branch more seldom, especially in the crown, and that the calcigerous tubes are large, very short, and branch freely. The internal differences are. therefore, very slight, if there be any at all; for I cannot understand how he arrived at his conclusions about the canals and tubules. I have examined numerous teeth of all kinds under the microscope, and I should not like to say positively with regard to any tooth that it was a different genus merely because the medullary canals were larger and branched less than in another specimen closely allied to it in external appearance, for in no other characteristic do they vary so much; even the teeth of the same species are different in this respect.

We have now seen what are the chief differences between these teeth, and what is the geological position which up to this time they have been considered to hold. It only remains for me now to compare the specimens I have under my notice at present with drawings of acknowledged *Hybodus* and *Cladodus* from the "Poissons Fossiles" and "The Geological Survey of Illinois."



Teeth of *Hybodus* (Figs. 1 and 2), compared with teeth of *Cladodus* (Figs. 3–6).

[Since the above paper was written I have examined the minute structure of the teeth of *Hybodus* obtained from the Wealden of Sussex and from the Northumbrian Coal Measures, and I find that they are almost identical. Engravings, exhibiting their microscopical structures, appeared in the "Monthly Review of Dental [illegible]" for February, 1874.]

As I have before remarked, all teeth resembling *Hybodus* were judged to belong to the genus *Cladodus* if they were found in the Carboniferous strata; but in any case, whether they are two different genera, or whether they are all *Cladodus*, their appearance in these Measures is very rare indeed. I have examined during the last few days the collections of three different local palæontologists, and have been able to discover only sixteen teeth among them, all of which, however, are very well shown, so that their characteristics can be easily detected. Among these sixteen teeth only two present the external form and appearance described by Agassiz as belonging to *Cladodus*, one being in the possession of my father, the other in the cabinet of Mr. Simm, of Cramlington; these two teeth I have exhibited in Figs. 6 and 7, and for the purpose of comparison I have drawn Figs. 4 and 5, the first being *Cladodus mirabilis*, from fig. 2, table 22, of the third volume of the "Poissons Fossiles"; the second, *C. lamnoides*, from fig. 16, plate i., of the second volume of the "Geological Survey of Illinois." There can be no doubt, therefore, that these are two specimens of true *Cladodi* teeth, that is, if there be such a genus as *Cladodus*, for I have a very strong impression that it is only a variety of *Hybodus*, but I do not propose to enter upon the consideration of that question at present.

The remaining fourteen teeth do not present any similarity to the above drawings and descriptions of *Cladodus*, but do resemble in every particular the description I have given of *Hybodus*; and the comparison of them with acknowledged teeth of *Hybodus* will, I think, remove all doubt that there may yet exist on this subject. Figs. 1 and 2 are copies of *Hybodus cuspidatus* and *H. plicatalis* respectively, as drawn by Agassiz in fig. 6, table 22a, and fig. 11, table 24, of the third volume of his great work. Fig. 3 is a tooth from the Coal Measures of Staffordshire, and was sent by Mr. Ward, of Longton, as a perfect specimen of *Cladodus*. The specimen is certainly perfect, for every trace of shale has been removed from it, so that it can be examined on all sides. The remainder of the teeth resemble Fig. 3 generally, but differ, as according to Agassiz they should, in having the secondary denticles unequally arranged on each side of the central cone. The arrangement of the fourteen teeth is as follows: in one there is one secondary denticle on one side of the principal denticle, and none on the other; this secondary denticle is very small, and not well developed, as in *Cladodus*; in one there is one on each side, neither of which are developed; in four there are two on one side, and one on the other; in two, two on each side; in one, three on one side, and one on the other; in three, three on one side, and two on the other; in one, four and one respectively; in one, four on one side, and two on the other. In every case where there is more than one denticle on one side, they *decrease* in size, as in Fig. 3. It will be observed that the similarity of these teeth with the description of *Hybodus* as given by Agassiz is so complete that in no case are there more than four denticles on one side.

These facts prove conclusively that *Hybodus* existed long before the period assigned by Agassiz and other writers, and was probably as plentiful in the true Coal Measures as in the Lower Lias. I am not aware whether these so-called teeth of *Cladodus*, which I have shown to be *Hybodus*, have ever been found in the Subcarboniferous Limestone, but I know that the teeth of true *Cladodi* have been found in that series of strata. The teeth of both *Hybodus* and *Cladodus* from these Measures have been obtained in close proximity to, and even buried in, masses of shagreen and cartilage, and also associated with the spines and tubercles of *Ctenacanthus* and *Gyracanthus*. I hope in another paper to show from specimens in my possession that *Ctenacanthus* pertains in all probability to the same fish as the teeth of *Hybodus*, and that it therefore does not belong to a separate genus called *Ctenacanthus*, but to a variety of *Hybodus*.

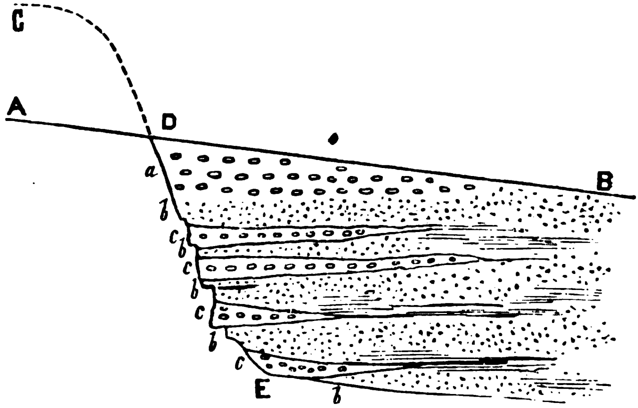
V.—GLACIALOID OR RE-ARRANGED GLACIAL DRIFT.

By G. H. KINAHAN, M.R.I.A.

(*Concluded from page* 117.)

Let us now consider the recent drifts that in other places are being formed at the present day. In portions of the sea-coast of Western Ireland, but especially in Galway and Mayo, there are cliffs of glacial drift margining the Atlantic. These are degrading away yearly, the detritus being carried away to form submarine and estuarine deposits. Generally, on the open seaboard, these materials, prior to being re-deposited, are so tossed about that they retain no indication of their former origin; but this is not the case everywhere, for in the bays and archipelagos they are in places very little changed, and different varieties of drift are being deposited, namely, fine silt or mud, sand and gravel, and a nearly unchanged or Glacialoid drift, the latter consisting of all or most of the materials

Diagrammatic Section, showing the relations between an ancient cliff of glacial drift and the rearranged or Glacialoid drift with the associated shelly drifts.



A, D, B, present surface of the ground, due to meteoric denudation.
C, D, E, ancient cliff of glacial drift.
a. Glacialoid drift, due to meteoric weathering.
b. Sand, gravel, clay and marl.
c. *Glacialoid drift,* due to sea action combined with landslips and other meteoric action.

of which the cliffs were composed. These varieties of the re-arranged drift dovetail or graduate into one another, but most of the mud is deposited far out, or in deep still places, while the sand and gravel accumulate nearer in shore, or in places where there are currents, and the Glacialoid drift is characteristic of the shore deposits. The last is principally formed after heavy weather, where the cliffs have been undermined or shaken, so that landslips take place. In heavy weather these materials due to landslips will be carried out much further than ordinary, forming widespread thin sheets, while at other times they will be more compact. Sections of such recent accumulations can seldom be examined, but on rare occasions they are exposed during extensive excavations for docks and other sea works. It can easily be understood, as the sea only denudes the drift forming its margin to a certain depth, that underneath these recent marine deposits there may be a continuous mass of undisturbed Boulder-clay drift (unless it is displaced by Post-Glacial faults); while the *Glacialoid drift* may join into the glacial drift, but although it may be very similar in aspect, is in reality unconnected with it, and a member of the more recent marine drift, the blocks and fragments that give it its supposed glacial character having been derived nearly unchanged from the Boulder-clay drift. It should also be mentioned that in many of the deposits of *Glacialoid drift* accumulating in these estuaries and bays, most of the blocks and fragments of stone, as in some river gravels, are arranged more or less on edge.[1]

What is now happening in places on the west coast of Ireland seems to be nearly similar to that which in former ages took place in the south-east of Ireland. In the area comprising the greater portion of the co. Wexford, and the south-east part of the co. Wicklow, it is quite apparent that prior to the glacial period the principal valleys were more or less excavated or opened along lines of breaks and other weak portions of the subjacent rocks. Afterwards some of these valleys were obliterated by large accumulations of Boulder-clay drift; while others, as Dana has pointed out of other places, were during the glacial period occupied by sub-glacier rivers. Subsequently some of the filled valleys were more or less re-excavated, and during the Esker sea period most, if not all, of them below the 250 feet contour line were filled by shelly drifts, to be again re-excavated in more recent times, partly by marine and partly by meteoric denudation.

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[1] This pitching or being on edge of the blocks and fragments of the "re-arranged glacial drift" I have observed in the drift in different places; but in none do they appear to be so conspicuous as in the co. Wexford, where they are characteristic of the Glacialoid drift, some of these drift sections being a mile or more in length. In accumulations forming at the present day I have observed blocks or fragments on edge in the following: at the bends of rivers, especially in mountain streams; in masses of drift due to landslips, where the mass has slipped outwards, and not gone down perpendicularly; and in the in-shore accumulations in estuaries, where the drift between the base of the cliff and low water-mark may have all or most of the contained blocks and fragments on edge. I can also imagine shore-ice or an iceberg pushing along on a mass of drift would shove up the blocks and fragments. Mr. A. Wyley, late geologist to the Government of the Cape of Good Hope, thus writes on the subject:—"A solid body, such as a landslip or a moving iceberg, would, I fancy, lift stones off the flat, and set them on edge; the horizontal thrust in either case overcoming the force of gravity and acting at right angles to the same. In other words, as, under the action of gravity, flat stones arrange themselves at right angles to the force, so, in case of a force acting at right angles to the force of gravity, it is natural that the flat stones should change their position in the same degree; but as the force of gravity would still be acting, their position would in most cases be determined by a 'component' of the two forces. This explanation will only apply to where the mass of mud has been moved by some strong horizontal force, and may also account for the fact of the more or less upright position of slates and such like stones at river bends, where there is always a strong horizontal force in the eddy." In the co. Wexford the upright position of the stones may in part be due to shore-ice or stranded icebergs; but it seems more probable that the drift was similarly formed to the shore accumulations of some estuaries of the present day, as all these drifts are adjoining what must have been land when the shelly drifts were being deposited, the great lengths of the sections being due to the present cliffs running with very similar, if not nearly identical, bearing to the cliffs that bounded the *Pre-drift islands.*

During the "Esker sea period" the area we are now considering was an archipelago, studded with various shoals and islands, the largest of the latter being the land that is now known as the Forth or Three Rock Mountains; and through this archipelago the principal currents seem to have flowed from the southward towards the northward.[1]

[1] Off the present coast of south-east Ireland the principal current runs from south towards north; and from the headlands, bars and banks extend northward, in which the materials become finer as we proceed in that direction; while westward, or inside these bars and banks, fine materials are accumulated. On the coast south of the headlands, which are open to the full force of the current, the accumulation is well-washed sand, gravel, or shingle: and, as similar relations exist between the different deposits and the ancient islands and shore-line of the sea of the "Esker period" in this part of Ireland, we are led to believe that then, as now, the principal current flowed from southward to northward. It is commonly believed that the chalks and flints found in the drifts of the cos. Wicklow and Wexford come from Antrim in the north of Ireland. I, however, see no reason for such a supposition; for if they came thence, the drifts, as we proceed northward along the coast through the counties of Dublin, Meath, Louth, and Down, ought to become more and more chalky, which is not the case; for when we proceed northward out of Wexford, we lose all the great marl deposits, such as would be formed from the denudation of chalk. The marls of Wexford and the adjoining portion of Wicklow would seem to be the washing from some of the chalk in England or France, while the sands associated with the marls are similar to the detritus formed by marine or meteoric abrasion from the associated rocks of the greensand formation. Furthermore, the pieces of chalk found in the drift are more like the hard beds in the English chalk, the "Chalk rock" of Whitaker, than any of the Antrim chalk. Mr. Wyley, however, who has carefully examined the counties Wicklow and Wexford, thus writes:—"That the chalk flints are from the Irish chalk, not necessarily from Antrim, is proved by the following considerations. A very large proportion of the flints are altered into jasper of various sorts; many are agates and chalcedonys, which are only found when the chalk has been subjected to strong volcanic action, as in the North of Ireland. Besides, I have in my possession a flint, picked up near Carn Point, with a peculiar coral, at once identified by the late Mr. G. V. Du Noyer as similar to ones he had seen in the chalk of the North. The abundance of these flints and jaspers at Carn Point and thereabouts, as well as in the bight of Cardigan Bay, at Aberystwith, etc., on the same parallel, simply arises from the continual tidal action grinding all into sand and mud except the flints. These I consider are all out of one of the drifts, and that not the marl; probably the old glacial drift, which, as indicated by the rock markings of the district, came from the N.W. It is barely possible, as the chalk or its equivalents extends through Belgium and Northern and Eastern France to Northern Germany and east of the Elbe in Bohemia and still further eastward, they may at one time have possibly extended to the valley between Carn Point and the *Welsh coast, the present* St. George's Channel. In the great limestone plain of

Some of the islands were rocky masses or rocky detritus, while many of them, especially those to the south-east, were composed wholly of glacial drift. During the "Esker sea period" the islands, wholly or partly formed of drift, were more or less denuded, some being totally submerged, while others, when the land finally began to rise again, were bounded by drift cliffs of a greater or less height. During the progress of the denudation of these islands various layers and beds of re-arranged or *Glacialoid drift* must have been deposited, interstratified with and graduating into the sands, clays, and marls; while subsequently to the retreat of the waters the drift cliffs would slip and weather away, forming a drift talus over the other drift, more or less long, according to the nature of the materials that formed the drift cliff (*see sketch*, p. 168). The drift in these meteoric slopes would necessarily be very similar to the drift in the original cliffs, being composed of the same materials; and if the cliffs consisted of glacial drift, the meteoric talus would be almost undistinguishable from glacial drift: yet of course it could not be so classed, as it had been re-arranged by meteoric action, and would be more or less stratified, while typical glacial drift is unstratified. In some of the valleys of the Carlow Hills, Glacialoid drift, due to meteoric action, is found extending in thin sheets for over 100 yards on to recent peat, so that the turf-cutters have to clear away from one to twelve inches in thickness of drift before they come to the peat; yet this "clearing" graduates into a drift that would by many be called glacial. Some of the re-arranged drifts, capping the shelly drift of the co. Wexford, are typical *Glacialoid drift*; but others which have covered them to a considerable depth, and now extend a long way over them, are similar, except that they are stratified, to the peculiar drift made up of rock detritus so common in parts of Waterford, Kilkenny, and other places in Ireland. This kind of drift[1] forms in places high sea-cliffs; and if such cliffs were exposed to much meteoric abrasion, they would form longer slopes than the weathering of typical glacial drift. When this class of drift overlies the marl in the vicinity of the hills that during the Esker sea period must have been islands, there are often, at the height of a few feet above the marl, lenticular sheets of a brecciated drift, locally called "rubble beds," made up of angular blocks from six to twelve, or even eighteen or twenty-four inches long, similar to the shoreformation found in the recent marine depositions close to the base of some sea-cliffs. This breccia ranges from a few inches

Ireland and the Silurians and granites to the east of it there are ample materials for the formation of the Wexford marls, in which you will find, though rarely, limestone pebbles. I always looked on these marls as the deep-water representatives of the limestone [Esker] gravels which choked up all the valleys through the mountains to the west and north-west, while the marls and clays were deposited in the shelter of the latter."

[1] This peculiar drift is often similar in aspect to the "foundation" or "broken shelf" (of the miner), made up of the underlying rock debris, found in many places between the typical glacial drift and the solid rock. In Tyrone, Londonderry, Galway, and many other places, it lies between the glacial drift and the rock, and is of inconsiderable thickness; but in some of the southern counties it is of a great thickness, and unassociated with any typical glacial drift. The rocks under it I have never found to be *ice-dressed*.

to two or three feet in thickness. The re-arranged angular detritus in the marl pits, north of the Forth Mountains, is rarely over eight or ten feet deep, though this is probably not its maximum thickness, as a marl deposited near a high cliff ought to have a greater depth of this detritus over it, and in some sections on the coast the detritus covering is much thicker; therefore it is probable that inland its full thickness has not been discovered, as the raising of the marl would not pay if too great a surface had to be removed.

It has now been demonstrated that all the so-called "upper glacial drift" of S.E. Ireland is probably only *Glacialoid drift*, or "re-arranged glacial drift," either by marine or meteoric action. It must, however, be allowed, as pointed out by me in a former paper,[1] that during the "Esker sea period" some of the mountain groups had still their glaciers, and possibly during this time some glaciers may have existed in the valleys of the Wicklow and Carlow Hills, which sent down their detritus on to the shelly drifts; consequently in a few subordinate places a true glacial drift may cap the shelly drifts; such deposits, if they exist, must necessarily be isolated, and of subordinate importance, and do not affect the general question.

The loose practice, adopted by many observers, of grouping together Glacial and "re-arranged or Glacialoid drift," has led them into the error of imagining that two distinct Glacial periods existed over tracts of country, where in reality there is only evidence for one; the re-arranged or Glacialoid drift being a member of the gravelly or fossiliferous drift, all being products produced contemporaneously by very similar causes. If, however, they still insist on keeping the stratified re-arranged glacial drift as a member of the Glacial group, they should also include therein the Esker and other gravels and sands, and every kind of accumulation that has been formed by the re-arrangement of the glacial drift.

In a paper like this some reference should be made to the shelly drifts of the Wicklow and Dublin Mountains, which were found at an altitude of about 1200 feet, by the Rev. M. H. Close on the Three-rock Mountain. This extraordinary height to which the shelly drift ranges in this portion of the mountain group it is hard to account for; but I am led to believe it is due to the elevation of an oblong tract with a general N.N.E. and S.S.W. direction, here raised, much more than in the rest of the country, while associated with the elevation was the formation of great Post-glacial faults.[2] These N.N.E. and S.S.W. curves of elevations and their associated faults would seem to have had their greatest upthrow in the neighbourhood of the Three-rock Mountain, it diminishing gradually towards the S.S.W., but more rapidly towards the N.N.E.[1]

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[1] Notes on some of the Drift in Ireland, Dublin Quarterly Journal of Sciences, vol. vi. p. 249 et seq.

[2] The faults traversing this country have not been worked out; but I would suggest that a fault with an upthrow to the N.N.W. runs along the valley of the Bray river. This, however, would seem to be shifted and displaced by transverse faults, such as the faults in Glencullen, Sally Gap, Glenmacanass, Glenavonbeg, etc.; while there are s of elevation, nearly parallel to the valley of the Bray river, one crossing ns obliquely in a S.S.W. line from Laragh, while a second nearly rs a little further to the N.N.W.

In favour of the supposition that the great altitudes of the shelly deposits in the mountains at the junction of the counties of Dublin and Wicklow are due to the combination of axes of elevation and great faults, it may be pointed out that in the country to the N.W. of these hills, if we come S.S.E. from the central plain of Ireland to the Dublin and Wicklow hills, it will be found that the altitude of the gravelly drift gradually increases; while south of this mountain range in the co. Wexford, according to Mr. Wyley's observations, this drift is not to be found higher than the 300 feet contour line. These anticlinal curves, with their accompanying faults, must be more or less shifted by the more recent faults of the valley of the Barrow, and of the other nearly N. and S. fissures, as west of the Barrow fault the altitudes at which the shelly drift is recorded are much less than those to the east. The following are the localities associated with the Dublin and Wicklow hills and east of the Barrow valley fault, in which shells are recorded: near Three Rock Mountain 1200 feet, Rev. M. H. Close; Sugarloaf Mountain 600 feet, Dr. Oldham; Bohernabreena, between 400 and 450 feet, Dr. J. R. Kinahan; Telegraph-hill, Killiney, 400 feet, Dr. Oldham; and at Naas, 380 feet, Dr. Oldham. West of the Barrow valley fault shelly drifts are only recorded in two places, both by Dr. Oldham, one in the range of hills immediately west of the fault, "on the flanks of the elevated coal-field, between Athy and Castlecomer" [height not given], and the other on the N.W. of the Slieve Bloom range at Roscrea, co. Tipperary, at a height of 400 feet.

In conclusion, I would wish to draw attention to the fossiliferous drifts that in places have been found under glacial drift, and have been called by me in previous writings "Pre-glacial drift." [Mem. Geol. Survey, Ex. Sheets 115 and 116, page 28; GEOL. MAG. Oct. 1865.] These are indeed to a certain extent pre-glacial, as they occur under glacial drift; but it appears probable that they would be more correctly spoken of as *Intraglacial beds*, being older than a portion at least of the Moraine drift of the adjacent height, but newer than the Boulder-clay drift of the central plain of Ireland. This drift at present seems to be only recorded in three places, namely, Boleyneendorrish river valley, adjacent to Gort, co. Galway, where it was observed by myself; in a pit at the Newtown colliery, Queen's co., where it was discovered by Mr. B. B. Edge, of Clonbrock Ho; and near Nenagh, co. Tipperary, where it was recorded by Mr. Wilkinson; the lignyte and associated beds at Lough Neagh, cos. Tyrone and Derry, and the deposits of pipe clay with lignyte in the vicinity of Cahir, co. Tipperary, may possibly be other representatives of this drift. In the first locality it lies under a drift which seems to be due to a glacier that came down one of the valleys of Slieve Aughta, and probably was entombed during a severe season, when the glacier exceeded its normal length, thereby burying a lacustrine accumulation under Moraine drift. In the second case the interbedded peat occurs on very high ground, and is undoubtedly in part covered by Moraine drift; but whether the whole of the 96 feet over it is of that nature, I cannot say, as the pits were closed long before the country was visited.[1] Of the third locality only a very scanty record is given, and from it the forty feet over the peat might be either Boulder-clay or Moraine drift;[2] there is, however, on that country a considerable quantity of Moraine drift that has been supplied by the ancient glaciers from the neighbouring hills.

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[1] It should be mentioned that on the east of the St. George's Channel, opposite to those in Wicklow, are found still higher deposits of shelly drift. The Welsh shelly drifts are, however, separated from those in Wicklow by the system of faults that occur in the valley of St. George's Channel, which is probably in the aggregate a great downthrow to the westward, as the drift in the east margin of Ireland *seems to rise towards the upthrow* of a fault.

Since the above was sent to press I learn from Prof. J. McK. Hughes, of Cambridge, that he believes "the whole of the beds containing the recent temperate shells in North Wales and to the north and east of St. Asaph are merely the result of a Post-Glacial sea eating back cliffs of Boulder-clay." "It is known that there have been great changes of level since the great cold, and whenever the sea washed the base of a Boulder-clay cliff, it must, as now, have undermined it, and mixed up re-sorted Boulder-clay and shells of the later period, while here and there great slips would throw old beaches on end and bury large masses of clay in sand and shingle." I also find that Professor Hughes has stated this a short time since at a meeting of the Geological Society of London.[3]

NOTICES OF MEMOIRS.

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MINERALOGY.

I.—Corundum; its Alterations and Associated Minerals. By F. A. Genth. *Contributions from the Laboratory of the University of Pennsylvania*, No. 1. Pp. 46.

THIS memoir relates mainly to the occurrence of Corundum in North America. The largest deposits occur in the chromiferous serpentine, or chrysolite formation, and in the adjacent rocks, although the mineral is also found in small quantity in rocks of Laurentian age, and in certain slates referred to Dr. Emmons' Taconic system. Dr. Genth thinks it not improbable that the emery beds in Asia Minor and in Greece may correspond in age with the corundum and emery of the chromiferous region in the States.

The author describes a large number of minerals which occur in association with the American corundum, and are supposed to result in some cases from its alteration. Among these substances are four new minerals, described under the names of *Dudleyite*, *Kerrite*, *Maconite*, and *Willcoxite*.

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[1] Geol. Mag. Oct. 1865. and Mem. Geol. Survey, Ireland, Ex. Sheet 137, p. 50.

[2] *Paper by T. Oldham*, M.R.I.A., Journ. Geol. Soc. Dublin, vol. iii. p. 195.

[3] *Geol. Mag.* Jan. 1874.

Dr. Genth's studies lead him to conclude—"1. That at the great period when the chromiferous chrysolite beds (in part subsequently altered into serpentine, etc.) were deposited, a large quantity of alumina was separated, which formed beds of corundum. 2. That this corundum has subsequently been acted upon, and thus been changed into various minerals, such as spinel, fibrolite, cyanite, and perhaps into some varieties of felspar; also into tourmaline, damourite, chlorite, and margarite. 3. That a part of the products of the alteration of corundum still exists in the form of large beds of mica- (damourite-) and chlorite-slates or schists. 4. That another part has been further altered and converted into other minerals and rocks, such as pyrophyllite, paragonite, beauxite, lazulite, etc."

F. W. R.

II.—On a Pseudomorphous Formation after Felspar. Ueber eine pseudomorphe Bildung nach Feldspath. Von Dr. Richard v. Drasche. *Tschermak's Mineralogische Mittheilungen*, 1873, Heft ii. pp. 125-128.

THE pseudomorphs forming the subject of this communication were obtained from a limestone-quarry near Budweis, in Bohemia. This limestone incloses, among other minerals, large rounded masses of a greenish substance, resembling steatite. Each mass, when broken open, usually exhibits a white or greyish nucleus of ellipsoidal form, sharply separated in most cases from the enveloping mineral. The following analyses exhibit the composition of the nucleus (I.) and of the surrounding substance (II.).

	I.	II.
Silica	60·49	34·63
Alumina	24·33	17·13
Ferrous Oxide	. . .	1·61
Lime	4·07	. . .
Magnesia	1·46	33·38
Potash	4·23	. . .
Soda	5·04	. . .
Loss on ignition	1·69	13·93
	101·31	100·68

It appears from these analyses that the composition of the nucleus is that of a felspar approximating to *andesine;* whilst the green investing mineral stands near to *pennine* or to *pseudophite*, and is evidently a product of the alteration of the felspar. F. W. R.

III.—On Syngenite. Ueber den Syngenit. Von dem c. M. v. Ritter v. Zepharovich. *Sitzungsb. d. k. Akad. d. Wissensch.: Math.-Naturw. Classe.* lxvii., 1873, pp. 128-142.

SYNGENITE is a new mineral species, discovered a short time since in the salt-deposits of Kalusz, in Eastern Galicia. It occurs in association with cubic crystals of rock-salt, and in general appearance resembles gypsum, from which it differs, however, both in its hardness and in the character of its cleavage. Chemical examination showed that it was closely related to polyhalite, and this relation suggested to Zepharovich the specific name (*συγγενής, related*).

Syngenite is a hydrous double sulphate of calcium and potassium, containing $CaK_2S_2O_8.H_2O$ (corresponding to the rational formula $CaO \cdot SO_3 + K_2O \cdot SO_3 + H_2O$). Its crystals, though commonly affecting a monoclinic habit, were originally described as rhombic, partly on account of their optical characters, and partly because their forms resembled those of the corresponding artificial salt, which was believed to be rhombic. The present paper describes in great detail the crystallographic and optical characters of Syngenite, and the author shows that both this mineral and the artificial salt must be referred to the monoclinic system.

The mineral recently described by Rumpf under the name of *Kaluszite* seems to be identical with Syngenite.

Zepharovich's paper is accompanied by figures of the principal combinations exhibited by the crystals of syngenite, and by a stereographic projection of the poles of 21 observed planes. F. W. R.

PETROLOGY.

IV.—Microscopic Examination of some Porphyrites and Allied Rocks from the District of the Nahe. Mikroskopische Untersuchung einiger Porphyrite und verwandter Gesteine aus dem Nahe-Gebiete. Von Herrn Prof. A. Streng. *Leonhard u. Geinitz's Neues Jahrb. f. Mineralogie, u.s.w.* 1873, Heft iii. pp. 225–241.

SOME time ago, Prof. Streng published the results of a microscopic study of the rock called *Palatinite*, which occurs in the Valley of the Nahe, a tributary to the Rhine. In the present paper he extends his researches to the other crystalline rocks associated with the Rothliegende of this district, and describes in detail the microscopic structure of the following rocks, namely — (1). A Quartz-porphyry, from Münster on the Stein. (2). An Orthoclase-porphyry, from the foot of the Unterhäuser Berg. (3). A porphyrite, from the southern foot of the Gienberg. (4). A grey porphyrite, containing tridymite, from near the railway-station of Waldbökelheim. (5). A brown porphyrite, from the same locality. (6). A porphyrite, from the valley below Bokenau. (7). A dark porphyrite, occurring in loose fragments in this valley. (8). A brownish-grey porphyrite, from the same locality. (9). A quartziferous Palatinite, from the foot of the Welschberg.

These nine rocks fall into a natural series, having at one end a quartz-porphyry, containing quartz, orthoclase, a triclinic lime-soda felspar, and a little hornblende. By gradual diminution in the proportion of quartz and orthoclase, a transition is effected, through the quartziferous porphyrite, to the typical porphyrites, which consist mainly of a lime-soda felspar and hornblende; thence, by addition of an augitic mineral and removal of hornblende, a rock may be obtained with the composition of Palatinite, which therefore constitutes the final term of this series. F. W. R.

V.—Observations on the Detrital Tin-ore of Cornwall. By W. J. Henwood. *Journal Royal Institution Cornwall*, No. xv. 1874.

THESE deposits in Cornwall and Devon have been worked for ages, and are now nearly exhausted. This paper refers chiefly to those few still in progress.

Between the Land's End and St. Ives the granite and slate are crossed by lodes, differing in direction and character in different parts. To the south they are poorer, in the central tract richer, and in one spot tin-ore is generally disseminated; to the north and north-east many rich lodes have been and are largely worked, sometimes long irregular "off-shoots" spring from the lodes, and at one place immense metalliferous masses occur in the granite. In this tract tin-ore has been the chief product, though other ores have been worked.

At Bosworlas a narrow strip of "tin-ground" (granitic gravel, with pieces of tin-stone, etc.) is worked, at a depth of about 3ft. from the surface, having a sea-ward slope down the ravine, and varying much in thickness (3in. to 30in.) from the uneven surface of the granite beneath.

Near Bejowans the tin-ground occurs at a rather greater depth below gravel, sand, and peat. Other places give like sections, and generally there is an uneven surface of granite beneath.

Around the Camborne granite-tract there are lodes with tin-ore, specially near the southern boundary, and the streams crossing hese parts are still worked for tin, the sections being of the same ind as before, and the detrital matter sometimes resting on the outrop of tin-bearing veins in the granite. Near Tregedna the stream n-deposit is overlaid by from 20ft. to 30ft. of mould and hardened lt. The largest body of stream-tin wrought of late years is near estrouguet-creek, not only by open works, but by shafts 50 or 0ft. deep, and drifts below the water.

In the central district (Hensbarrow) tin-ore occurs not only in the des, but is sometimes scattered through the granite (St. Austell), nd the detrital deposits on the north and east are still worked. hree sections, of varying depth, near St. Austell, show like deposits with peat) to those noticed above, and there are others close by. n Tregoss Moors, which are on the slate, often soft, and with elvans," three shallow sections are still open.

The eastern district includes the great granitic range, the highest art of Cornwall. The granite, slate, elvan, and hornblendic rocks are l crossed by lodes and cross-veins. Tin-ore occurs in some of the des, and also in scattered masses. Near St. Neot stream-tin is worked.

The water-shed of Cornwall has several flexures, but its range is early always much nearer to the north coast than to the south; onsequently the shorter and swifter brooks on the north have reater wearing and carrying powers than the longer and slower reams on the south, and the former, therefore, deposit very little atter in their beds, whilst the latter deposit more.

The *débris* of the bed beneath the tin-ground always prevails in . Other ores than tin-ore occur. The proportion of tin-ore in one f the richest *works scarcely* exceeded that in one of the poorest lodes, but the metal from the stream-ore is the best. Gold has been found, but very sparingly, in the detritus of every tin-district.

The blocks and smaller fragments on the tin-ground show marks of abrasion, and the interstices are filled with sand and clay. The bed that rests on it is scarcely distinguishable from it, but that its ingredients are perhaps less abraded, and that it is almost destitute of tin-ore. The bed next above this has a likeness in neighbouring valleys, and yet sometimes differs in different parts of the same valley: it seems that after the tin-ground was deposited timber sometimes flourished in the lower valleys, and brushwood in the upland glens, subsequent change in the relative levels of land and sea affecting the former more than the latter; and that the deposit of barren *débris* was once or twice interrupted by a large formation of peat. Vegetable remains of the same kind occur within short vertical distances from the "tin-ground" both north and south of the water-shed.

The deep valleys which formerly opened to the sea below high water mark, on the south coast, contain alternations of mineral wit vegetable matter, and of fresh-water with salt-water deposits.

In the shallow stream-works of the moorlands the upper parts co sist of much the same ingredients as the neighbouring rocks, are li the beds of the neighbouring brooks, and are disposed in thin laye with clay-partings.

Detrital tin-ore does not occur only (though chiefly) in the lo grounds, but has also been found in abraded masses on the slopes hills, whence it has been traced to the parent lodes.

If detrital tin-ore has also been deposited in the sea, it must covered, as on land, by more recent deposits, soundings having faile to find it. At Cligger Head the ore derived from the waste of th cliffs is collected.

The paper concludes with three tables, giving the composition c the tin-ground and of the adjoining and neighbouring rocks, th comparison of vegetable remains in the upper and lower parts of th same and of different valleys, and the mineral composition an organic contents of the beds laid open in various stream-works.

Throughout is a very large number of foot-notes, giving reference to the many works on the district.
W. W.

VI.—Brief Abstracts.

1873.

Greenfell, J. G. *Streptorhyncus Kellii.* *Trans. Clifton Coll. Sc Soc.*, part iv. pp. 16, 17.

The shells were found in an "Oolitic" Limestone, from the lowe part of the Carboniferous Limestone (above the Black Rock), at th foot of the gully down to the river from the Downs, and are im portant as showing that *Streptorhyncus Kellii* of McCoy is only variety of *S. crenistria*, as suggested by Davidson. The deep mesia furrow and the rounded cardinal angles were the points on whic McCoy chiefly insisted as specific differences, and in one of thes *specimens the former* character occurs with acute cardinal angles whilst in others the mesial furrow varies very much in depth, being almost obliterated in some.

Greenfell, J. G. Lower Limestone Shales, Clifton. *Trans. Clifton Coll. Sci. Soc.*, part iv. pp. 17–23.

These beds, consisting of alternations of shale and thin limestones, separate the Old Red Sandstone from the Carboniferous Limestone, the thickness of the last being 1450 feet, and that of the shales 500. The "bone-bed," over 100 feet up in the shales, was once taken to be their base.

The new railway gives a good section, a detailed account of which (showing 148 beds, with a thickness of over 130 feet) is given, and the result of the examination is to throw the "passage-beds" of Mr. Sanders into the Carboniferous series, and to draw the line sharper between that and the Old Red Sandstone—Carboniferous fossils having been found to a lower depth than before.

The bearing that this may have on the "Devonian question" is noticed, and a conglomerate-bed is taken as the top of the Old Red Sandstone, which, however, may run a few feet higher. The beds seem to thin out rapidly along the strike (S.W.).

Greenfell, J. G. Iron Mine recently opened in the Royal York Crescent, Cifton. *Trans. Clifton Coll. Sci. Soc.*, part iv. pp. 46–53.

The mine is sunk in Millstone Grit, the upturned beds of which are overlaid by horizontal beds,. probably Triassic, five to twelve feet thick, and composed of clay with fragments and masses of hæmatite. At another pit, close by, these latter beds have not been bottomed at a depth of fifty feet, and a mass of hæmatite (probably lenticular). ten to twelve feet thick, is worked in them: they are the débris of the Millstone Grit beds. In the mine (an open pit) there are two beds of hæmatite, each four feet thick, with five of sandstone and one of shale (also rich in iron).

Most of the ore is Limonite, in six varieties; red hæmatite occurs in the inside of lumps of ore, and goethite in crystals coating the limonite, and in cavities of the hæmatite. Quartz and sulphate of baryta are associated with the iron-ore, the former disseminated through the hæmatite, and in crystals; as a rule, the silica has been deposited after the iron; the sulphate of baryta is in the form of small thin tables in cavities in the ore and in the sandstone-matrix.

The ore was introduced since the deposit of the beds, and the author thinks that the cavities in which it is found may have been formed by the dissolving away of limestone that once existed amongst the sandstone beds.

From the perpendicularity of the stalactitic masses of limonite, it is clear that the deposit of ore must have taken place after the beds were tilted into their present position. If, then, the overlying horizontal beds are Triassic, and the lumps of hæmatite in them were derived from the Millstone Grit, we can fix the date of introduction of the ore, viz. during the Permian and Bunter periods. The author thinks that the iron may have been derived from the carbonate of iron of *the Coal-measures* that have been denuded away *in the neighbourhood.*

5000 feet, clothed to the summit with perennial verdure; the volcano of Masaya, active at the time of the Spanish Conquest in 1522; close to this cone is situated the lake of Masaya, which is of large extent, and may perhaps at one time have been an old crater-lake, like that of Kilauea, in Hawaii. The walls of this lake are precipitous cliffs, 348 feet high, composed of massive trachyte, overlain by beds of ashes, breccia, and cinders; these are covered by a deposit of fine tufa, with imbedded angular masses of trachyte, some of which are more than three feet in diameter. The uppermost layer is composed of lightly-coherent tufaceous ash, worn into an undulating surface by meteoric agents.

In 1866 Mr. Belt published a paper in the Transactions of the Nova Scotian Institute of Natural Science (p. 93), on "the Glacial Period in North America"; it is not therefore surprising to find the author carrying on his observations of glacial phenomena in Central America. Nearly everywhere the author sees evidences of ice-action in the accumulations of gravel with boulders of gneiss, quartz, trap-rock, and conglomerate. "The evidences of glacial action between Depilto and Ocotal," writes Mr. Belt (p. 260), "were, *with one exception*, as clear as in any Welsh or Highland valley. There were the same rounded and smoothed masses of rock, the same moraine-like accumulations of unstratified sand and gravel, the same transported boulders that could be traced to their parent-rock several miles distant. *The single exception was,* I saw no glacial scratches on the rocks."

Without venturing for one moment to call in question Mr. Belt's accuracy as an observer, we cannot help thinking it possible that the effects of torrential action, and the accumulations of old sea-coasts, may, after elevation of the land and re-arrangement by river-action and other causes, be mistaken for glacial moraine matter; at any rate, so good an observer as the late Professor Agassiz certainly mistook alluvial matter for moraine matter in the Amazons valley.[1]

Again, at p. 262, the author says, "I could no longer withstand the evidence that had been gradually accumulating of the presence of large glaciers in Central America during the Glacial Period, and these once admitted afforded me a solution of many phenomena that had before been inexplicable. The immense ridges of Boulder-clay between San Rafael and Yales, the long hog-backed hills near Tablason, the great transported boulders two leagues beyond Libertad, ... could all be easily explained on the supposition that the ice of the Glacial Period was not confined to extra-tropical lands, but in Central America covered all the higher ranges and descended in great glaciers to at least as low as the line of country now standing at 2000 feet above the sea, and probably much lower."

Mr. Belt thinks geologists will be forced to the conclusion that "the Glacial Period was not only more extensive than has been generally supposed, but that it existed at the same time in the northern and southern hemispheres, leaving, at least on the American continent, only the lower lands of the tropics free from the icy covering." (p. 265.)

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[1] *See letter from* Mr. C. F. Hartt, Silliman's American Journal, No. 19, for July, *1872, p. 63. See also* Geol. Mag. 1873, Vol. X. p. 540.

The author proceeds to show "that there was much extermination of animal life during the Glacial Period," but "that many species found a refuge on lands now below the ocean that were uncovered by the *lowering of the sea*, caused by the immense quantity of water locked up in frozen masses on the land."

"Mr. Alfred Tylor considers that the ice-cap of the Glacial Period was the cause of a great reduction of the level of the sea amountiug to at least 600 feet.[1] But (Mr. Belt adds) if we admit that the ice-cap existed *in both hemispheres* at the same time, and extended nearly to the equator, we shall have to speculate on a lowering of the level of the sea to at least a 1000 feet." Strangely enough, in the sentence which follows this heterodox proposition, the author writes—"We have many facts tending to prove that during the extreme extent of the Glacial period *the land stood much higher above the sea than it now does.*" (p. 267.) Surely herein lies the whole explanation of Mr. Belt's difficulties. Islands and isthmuses are but the highest parts of much more extensive tracts of land, which, if elevated by plutonic agency, would (without any reduction of the volume of the sea) lay bare large tracts of land, often of continental extent, and unite island to island, and island to continent, so that the fauna might pass over dryshod, and the flora spread without the agency of man or animals to act as carriers.

If such explanations (which are deducible from known causes now in operation, and of which instances are actually capable of being brought forward in evidence) are amply sufficient to meet these zoological and physical geographical problems, why fly to theories which, to say the least, overstrain, if they do not actually violate the known laws of Nature, and override all our first principles both of physics and astronomy?

The present day is one of surprises and startling propositions. and it cannot be denied that, in the progress of scientific research and discovery, many of our preconceived and long-cherished notions have been swept clean overboard. It may be that the ideas propounded by the author shall hereafter become a part of the geological principles of a future day; but will the astronomer and mathematician allow as feasible, under any circumstances, the notion of an ice-cap 8000 feet or more in thickness simultaneously *at each pole*, and extending thence nearly to the equator over either hemisphere? We hope not; for the prospect presented to the mind's eye by such a world seems one of the dreariest that man ever pictured, only comparable in its melancholy lifelessness and annihilation to the vast frozen wastes of Arctic America and Northern Siberia. Even the author would, we think, turn from such a scene of desolation, and wish himself back in the virgin forests of Nicaragua, with its spider-monkeys and humming-birds, and never desire to see ice again as long as he lived! Mr. Belt's book should be read by all lovers of Natural History, and it is just the kind of book to make Naturalists of those *who are not*.

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[1] *Geol. Mag. 1872*, Vol. IX. p. 392.

II.—THE COAL FIELDS OF GLOUCESTERSHIRE AND SOMERSETSHIRE, AND THEIR RESOURCES. By JOHN ANSTIE. pp. 103. (London: Stanford, 1873.)

THIS work is devoted to a description of the Coal-basins between Tortworth and the Mendip Hills, familiarly known as those of Bristol and Radstock, Nailsea, and Clapton-in-Gordano. The last-mentioned is hardly deserving of such prominence, were it not for the discovery made known by Mr. Richardson of Coal-measures beneath the bed of the Severn, west of Almondsbury, which may possibly be connected with the exposures of Coal-measures at Portishead Point and Clapton.

Mr. Anstie gives detailed descriptions of the Coal-strata and of the structure of the basins with their many faults and disturbances. He has endeavoured to correlate the seams developed at the different mines—a feature which may be said to characterize the volume. This has not been attempted so thoroughly before. He points out the probable further extension of the Coal-measures, and states his estimate of the resources of the known area. The bordering rocks are briefly alluded to, and the work, which is essentially a practical one, is illustrated by nine plates of sections, both horizontal and vertical. H. B. W.

III.—THE SCHOOL MANUAL OF GEOLOGY. By the late J. BEETE JUKES, M.A., F.R.S., for many years Director of the Geological Survey of Ireland. Second edition, edited by ALFRED J. JUKES-BROWNE. 8vo. (Edinburgh: Black, 1873.)

TEN years have elapsed since the late Prof. Beete-Jukes brought out his 'School Manual,' which may be regarded as one of our best introductions to the science of Geology. This period, short as it may seem, has witnessed considerable progress in the different branches of the science; and to keep acquainted with all the results of geological investigation becomes every year a more difficult task. This new edition of Mr. Jukes's little work, which has been prepared by his nephew, seems worthy of its predecessor: the old matter has been carefully revised, and much that is new has been added. It may be difficult in an elementary work to decide as to how much detail to insert; some notices, however, of the Northampton Sand, Speeton Clay, and of the Gravel beds and great chalky Boulder-clay of the Eastern Counties might, we think have been given with advantage. Nevertheless, omissions such as these will not detract from the value of the book, which after all is not to describe the geology of a country, but to expound in an elementary form the leading principles of the science. This being the case, we gladly recommend it.

IV.—REVUE DE GÉOLOGIE. Par M. DELESSE et M. DE LAPPARENT. Tome x. (Paris, 1873.)

THIS useful contribution to geological literature has now reached the tenth volume, and is equally creditable to the editors for care and attention paid to its production as are the preceding volumes. As in the preceding years, the authors give a brief but methodical analysis of the numerous geological works and papers which were published during the years 1870–71. Among these papers many appear in foreign publications or as separate pamphlets, and might be overlooked, so that their arrangement in these annual reports is of great value to the geologist and others interested in the science. Besides notices of printed papers, the *Revue de Géologie* contains private communications from geologists and engineers, as well as unpublished analyses of rocks, which have been undertaken in private laboratories, or in those of the French School of Mines, and other establishments; and also notices of the works of Italian geologists furnished by MM. A. Caillaux and de Mortillet. The subjects are arranged under the following heads: Physiographical, Lithological, Historical, Geographical, and Dynamical Geology. Under these five divisions more than 180 papers are noticed, which, together with a list of 440 authors, shows the amount of labour bestowed by the editors upon this work. M. Delesse has specially charged himself with the lithological part, metamorphism, agricultural geology, and modern phenomena; while M. de Lapparent has undertaken the historical geology and the mountain systems, the other portions being a joint production.—J. M.

REPORTS AND PROCEEDINGS.

Geological Society of London.—Annual General Meeting.—February 20th, 1874.—His Grace the Duke of Argyll, K.T., F.R.S., President, in the Chair. The Secretary read the Reports of the Council, and of the Library and Museum Committee. The general condition of the Society was said to be very satisfactory; the Society was said to be prosperous, and the number of Fellows to have considerably increased.

In handing the Wollaston Gold Medal to the Foreign Secretary, W. W. Smyth, Esq., for transmission to Prof. Heer, of Zurich, the President referred to the fact that last year the Council had awarded the Balance of the proceeds of the Murchison Geological Fund to Prof. Heer, and remarked that it gave him much pleasure that the Wollaston Medal, the highest honour which the Society had it in its power to confer, should be so worthily bestowed. He alluded briefly to the labours of Prof. Heer in the difficult departments of Fossil Botany and Entomology, and to the admirable works in which he had given to the world the results of his indefatigable researches.

Mr. W. W. Smyth, in reply, said:

My Lord President,—It is with a great pleasure that I undertake the transmission to Prof. Heer of this new testimony of the importance attached by this Society to his long-continued labours. I have received from our valued Foreign Member a letter stating that my announcement of the award had found him extended on the bed of sickness, and begging me to assure the Society that, but for this misfortune, nothing would have given him greater pleasure than to have been present at this Meeting, and to have thanked the Society personally for the high honour which has now been awarded to him.

The President then presented the Balance of the proceeds of the Wollaston Donation Fund to the Foreign Secretary for transmission to Dr. H. Nyst, of Brussels, remarking that this distinction had been well earned by Dr. Nyst by his admirable researches upon the Molluscan and other fossil remains of his native country.

Mr. W. Smyth briefly thanked the President on behalf of Dr. Nyst.

The President next presented the Murchison Medal to Dr. J. J. Bigsby, F.R.S., F.G.S., and remarked in so doing that there was a peculiar fitness in this award, which would have met the approval of the distinguished geologist in accordance with whose last wishes this Medal was given. It was awarded to Dr. Bigsby in recognition of his long and valuable labours in that department of geology and palæontology with which the name of Murchison is more particularly connected.

Dr. Bigsby replied, thanking the Society for the honour conferred upon him, and the President for the terms in which he had spoken of his labours.

The President then handed half the Balance of the proceeds of the Murchison Geological Fund to R. Etheridge, Esq., F.R.S., F.G.S., for transmission to Ralph Tate, Esq., F.G.S., expressing a hope that it would be regarded by him as a testimony of the value set by the Society upon his palæontological researches, especially on the Fauna of the Lias, and that it would enable him to enlarge the sphere of his investigations.

Mr. Etheridge, in reply, read a suitable letter of acknowledgment from Mr. Tate.

The President then presented to Mr. Alfred Bell the other half of the Balance of the proceeds of the Murchison Geological Fund, and stated that this was awarded to him in recognition of his valuable researches upon the fossils of the newer Tertiary beds of this country, and to assist him in the completion of his work upon the Crag deposits of the eastern counties.

Mr. Bell, in reply, said that he was most grateful for this token of the Society's appreciation of the value of his labours.

The President then proceeded to read his Anniversary Address, in which he stated that the pressure of his official duties during the period of his Presidency had prevented his keeping himself thoroughly acquainted with the recent progress of geological research, and he therefore proposed in his present Address to advert rather to those questions in geology which seemed to him still to require an answer. He referred to the relations between geology and cosmogony, to the effects and causes of volcanic and earthquake action, and finally to the great questions which are still unsettled as to the origin of life and the sequence of organic beings on the face of the earth. The Address was prefaced by some obituary notices of Fellows and Foreign Members and Correspondents deceased during the past year, including Mr. J. Wickham Flower, Mr. J. Garth Marshall, *Prof. Agassiz,* *and M.* de Verneuil.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President:* John Evans, Esq., F.R.S. *Vice-Presidents:* Robert Etheridge, Esq., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; Sir Charles Lyell, Bart., D.C.L., F.R.S.; Joseph Prestwich, Esq., F.R.S. *Secretaries:* David Forbes, Esq., F.R.S.; Rev. T. Wiltshire, M.A. *Foreign Secretary:* Warington W. Smyth, Esq., M.A., F.R.S. *Treasurer:* J. Gwyn Jeffreys, Esq., F.R.S. *Council:* The Duke of Argyll, K.T., D.C.L., F.R.S.; H. Bauerman, Esq.; Prof. G. Busk, F.R.S.; J. F. Campbell, Esq.; Frederic Drew, Esq.; Sir P. de M. G. Egerton, Bart., M.P., F.R.S.; R. Etheridge, Esq., F.R.S.; John Evans, Esq., F.R.S., F.S.A.; David Forbes, Esq., F.R.S.; Capt. Douglas Galton, C.B., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; J. Gwyn Jeffreys, Esq., F.R.S.; Sir Charles Lyell, Bart., D.C.L., F.R.S.; C. J. A. Meyer, Esq.; J. Carrick Moore, Esq., M.A., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Prof. A. C. Ramsay, LL.D., F.R.S.; Samuel Sharp, Esq., F.S.A.; Warington W. Smyth, Esq., M.A., F.R.S.; Prof. J. Tennant, F.C.S.; W. Whitaker, Esq., B.A.; Rev. T. Wiltshire, M.A., F.L.S.; Henry Woodward, Esq., F.R.S.

GEOLOGISTS' ASSOCIATION.—February 6, 1874.—Henry Woodward, Esq., F.R.S., F.G.S., President, in the Chair.—1. "On the Probability of Finding Coal in the Eastern Counties." By John Gunn, Esq., M.A., F.G.S.

This paper may be regarded as an application of a former paper, "On the Dip of the Chalk," in order to prove the probability of finding Coal in the Eastern Counties. Sections of wells at Harwich, Camden Town, and Calais were added to those previously referred to at Yarmouth and Norwich. Mr. Gunn observed that the objections raised by the late Sir R. I. Murchison were satisfactorily disposed of by Mr. Prestwich, who showed, in his Report on the Coal Commission, that there was no proof of any deterioration or dying out of the measures, as stated by Sir Roderick; and that Mr. Godwin-Austen, in proof of their course along the valleys of the Thames and the Kennet, relied upon the opinion now entertained by engineers, "that surface features are guides to what long antecedently had taken place below, and the reason adduced is that the original sets of disturbances, which affected old Palæozoic strata, have always been on the line of subsequent disturbance, and are actual hinges, as it were, upon which these rock masses have moved since, and these rocks record these original physical lines in the disturbances which have taken place since," and Mr. Godwin-Austen strongly expressed his conviction, by affirming that "were I a Kentish or Essex landowner, I should be very much disposed to sink along a line parallel to the chalk escarpments of Kent, to the North-East of it." Mr. Gunn, in deference to so high an authority, gave the preference to a boring on the south of Essex, and proceeded next to build upon the above-established facts the grounds on which he recommended another boring at *Hunstanton, or along the* outcrop of the Kimmeridge Clay in Norfolk. He detailed the several papers which he had read at the Meetings of the British Association at Nottingham, Brighton, and Bradford, in proof of the existence of a Forest-bed in Norfolk and Suffolk, which he called the Anglo-Belgian basin, of a succession of growths of forests, and of alternate elevations and depressions which have taken place in that region, and argued thence by analogy the extreme probability that such existed in the Carboniferous epoch. He relied upon the fact that such coal-deposits would be at a workable depth, in consequence of the elevation of the land at Hunstanton about 1700 feet above its original position at Yarmouth; and this upheaval of the chalk afforded a complete refutation of Prof. Hull's statement, founded on the supposed dip of the slaty rocks of the Harwich boring, namely, that an old Palæozoic land-surface extended from Harwich over all the Eastern Counties into Scandinavia, as represented in his Map, appended to the Report of the Coal Commission, and that this old high and dry surface was incapable of coal-growth. Mr. Gunn submitted that, if the southerly dip of the Harwich slaty rock extended in a northerly direction, it must have been reached at the Norwich boring, which was sunk considerably lower than that at Harwich, and did not pierce through the Gault. Mr. Gunn dwelt especially upon this as the most serious objection to the prospect of reaching coal at Hunstanton, or rather a Carboniferous bed, an opinion expressed so strongly by the Professor at the meeting at Brighton. Mr. Gunn also referred to the evidence of local subterranean movements in proof of the proximity of disturbances acting upon what he regarded as a thin envelope of Tertiary and Secondary deposits, probably not exceeding 1000 feet, and perhaps much less. He referred to the evidence of boulders, which he hoped to adduce on a future occasion.

2.—"On the Geology of Nottingham." By the Rev. A. Irving, B.A., F.G.S. Part I.

CORRESPONDENCE.

MR. JAMES GEIKIE ON SCOTCH AND ENGLISH DRIFTS.

SIR,—Those who have read Mr. J. Geikie's papers in Vols. VIII. and IX. of the GEOL. MAG. will perceive that in his new work called "The Great Ice Age" he has changed his opinion concerning the correlation of Scotch and English Drifts. Instead of lumping together the three great drifts of the N.W. of England as varieties of "Till," he now agrees with the opinion I published in the GEOL. MAG. for Sept. 1872 (Vol. IX.), namely, that "the eskers of Ireland and kames of Scotland were piled up during some part of the [N.W. of England] middle sand and gravel period," and that the upper or brick clay is the representative of the Scotch shelly clay. This change of opinion has, I fancy, enabled Mr. Geikie to correlate more readily the drifts of this country with those of Sweden and America. Mr. Kinahan, in the last Number of the GEOL. MAG., does not believe *in the existence* of a decided upper Boulder-clay in Ireland. In the

N.W. of England it is a strikingly *original* formation, as proved by the freshness of the numerous and generally parallel striæ on the included stones. It is, however, confined to low levels.

D. Mackintosh.

FURTHER REMARKS ON VULCANICITY.

Sir,—The statement of your footnote at p. 127 of my Reply to Mr. Scrope (Geol. Mag. for March, 1874), in which you say that "Mr. Mallet in this and other passages certainly misapprehends Mr. Scrope," does not seem to me justified by the facts, and I beg of you to permit me to explain why.

The objections made by me to the supposition of a thin crust and a great liquid nucleus are alike applied by me to the hypothesis of Hopkins, of a thin crust covering his subterranean liquid lava lakes. I have throughout my reply linked these together. Whether, therefore, Mr. Scrope now continues to adhere to the former notion, as I am warranted in taking from the tenor of almost all his writings,—or whether, as in the papers in the Geol. Mag. Vols. V. and VI., to which you direct attention, he more recently is disposed to abandon the moribund thin crust and liquid nucleus theory, and to fall back upon the thin crust and fiery lakes of Hopkins (for the views in the papers above referred to seem to me neither more nor less than that),—I have not, as I believe,—certainly not consciously,—misapprehended Mr. Scrope. The difficulties of Hopkins' notion, as adopted by Mr. Scrope, are just as great as those of the older one of thin crust and liquid nucleus, with this additional disadvantage,—that whereas the latter is an assumption that may stand alone, the former (Hopkins' or Mr. Scrope's) is an hypothesis as arbitrary, and which cannot be admitted at all without admitting another hypothesis previously, upon which it must depend.

10th March, 1874. Robert Mallet.

ORIGIN OF THE FLEET.

Sir,—I can assure Col. Greenwood that I have read his valuable book more than once, and each time with considerable profit to myself; still I cannot agree with all his conclusions. My paper on the origin of the Lagoon called the Fleet is not as explicit as I would wish, as I intended to point out that the sea-banks are due to the principal currents, which are usually the incoming tidal currents. In some places, as off the S.E. coast of Ireland, the prevailing winds and incoming tidal currents act conjointly; but west of Carnsore point [the S.E. headland of Ireland] there are cross-tides, apparently due to the curl round the Salter Islands: and here we find, at the lagoon called Ballyteige mudlands, that the beach travels from Crossfarnoge Point towards the W.N.W., although the prevailing winds are from the S.W. and S.S.W.; while on the coast of Mayo, between Killiney Bay and Clew Bay [a coast apparently most favourable to the formation of bars and lagoons], the beach has no regular set, but goes sometimes north, at other times south, or inland or seaward, although there are on this coast nearly constant winds from between the south and west, *generally* a few points off S.W. From what I have seen, it would appear that, no matter how the wind blows, it has very little effect on shingle beaches, except while the tide is coming in; on sand beaches, however, it is otherwise, as the wind acts most while the tide is out, as it has a greater extent of bare sand to blow over. Perhaps, however, it is not fair to draw a comparison between the tidal work in the open seas west and south of Ireland with that effected in the narrow seas round England, as in the first there may be great oceanic waves rolling in, unaccompanied by wind, which, as on the previously-mentioned coast of Mayo, may obliterate all windwork; while in narrow English seas windwork ought to be more effective. Col. Greenwood in his letter (GEOL. MAG. March 1874, p. 143) states: "It is the prevalent S.W. wind which throws beaches across the mouths of our streams on the south coast,"—while I would suggest that it is the incoming tidal current from the W.S.W., aided in part by the wind, that is the great worker; for if wind could act alone, in no place would we find a beach travelling up wind.

On a coast where there are never any breakers or high waves except during winds, a vessel could not be floated by the tidal current over one of these sea-banks. But all shores are not so situated; for at Aranmore, at the entrance of Galway Bay, on the 15th Aug. 1862, during a perfect calm, a wave, over twenty-five feet high, came in and swept 15 people off who were fishing on the Glassan rock: while at the same island, in A.D. 1640, a wave, at least 60 feet high, came in and swept over the low portion of the island known as the Blind Sound [Mem. Geol. Survey, Ex. Sheets, 103 and 113, p. 12]. But in general great waves are due to the incoming tide with a wind blowing in a similar direction. G. H. KINAHAN.

ON THE ORIGIN OF THE ESTUARY OF THE FLEET. REPLY TO MR. KINAHAN.

SIR,—Mr. Kinahan has not attempted to disprove my theory of the formation of the Fleet, but has substituted another which he prefers. I have, however, some objections to offer to it. He considers the shore-line of the Fleet to have been formed by marine erosion. That this has not been the case appears evident from a mere inspection of the Ordnance Map. Compare, along the whole sheet, the outline of the open coast with that within the Fleet, and it will be seen at a glance that its character is totally different. "The old marginal cliffs" of the Fleet, supposed to have been degraded into slopes, never, in fact, existed. There are no cliffs old or new except the very low ones, which have been formed by the lap of the small waves got up within its confined area.

Mr. Kinahan says that "as long as the lagoon exists, so must the Chesil Bank, as the waters of the Fleet keep the bank from travelling inwards." This is incorrect, because the bank does travel inwards, slowly but surely, as may be seen by examining its inner margin. In heavy storms, like that of 1824, the sea washes over it, and heaps of shingle are thrust forwards into the Fleet, where they remain undisturbed.

I regret to say that I am not acquainted with the examples of lagoons in Ireland, to which the Fleet is supposed to be analogous. Probably Mr. Kinahan's explanation of their origin may be correct: but that the like will account for all the marshes and reclaimed low lands from Portland to Dover seems to me highly improbable. Take the same sheet of the Map, and observe the forms of the indentations of Weymouth Backwater, and of Lodmore; or further east, of Poole Harbour, Southampton Water, Portsmouth Harbour, Langston and Chichester Harbours. The action of the sea upon a coast composed of soft strata cannot possibly have formed these indentations. They must be drowned valleys.

I feel much supported in my views about the Fleet by the corroboration Mr. Mellard Reade has given to them.[1] O. Fisher.

Harlton Rectory, near Cambridge.

STALAGMITIC DEPOSITS.

Sir,—When the organic remains which are found buried in caves are receiving such general attention, and when attempts are being made to determine their age by the rate of stalagmitic deposits, I trust that the following case of such deposits may be of interest to the readers of the Geological Magazine.

About 30 years ago, I procured a piece of lime deposit from a lead mine at Boltsburn, in the county of Durham. It measured 18 inches in length, 10 inches in breadth, and fully ¾ of an inch in thickness. It was compact and crystalline, and showed distinct facets of crystals on its surface, over which the water was running. I have indisputable evidence that the deposit had been accomplished in 15 years. The water from which it was produced issued from an adit driven in the Little Limestone, which is about nine feet thick. After leaving the adit, the water ran down the perpendicular side of a rise, for some fathoms, on to some rock debris, which was lying on the bottom of a hopper, whence it proceeded from the upper part of the hopper mouth, then perpendicularly downward over two narrowish wood deals, which were set on edge, and put across the mouth of the hopper to stop the marked materials. It was from off these deals that I obtained the specimen above described. On its under side the forms of the deals were well defined; on the exposed surface, the crystals were best developed where the stream was most active.

In accordance with the above rate of increase, namely, ¾ of an inch in 15 years, 5in. would require 100 years, 4ft. 2in. 1000, and 41ft. 8in. 10,000 years. The data here given to arrive at these results may be relied on as being accurate. In the case now related, the rate of increase was likely to continue tolerably uniform, as the surface water could have no appreciable influence in augmenting or lessening the flow from the adit. John Curry.

Boltsburn.

Explanation of terms, if required.—A "rise" is an excavation made by the miner working from below upwards; size, generally about 9ft. by 4ft. A "hopper" is made by bratticing (or partitioning) off a portion of the rise, and putting timbering horizontally across the low part for a bottom; its use is to hold the worked materials.

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[1] *Geol. Mag.* Vol. X. p. 573.

Geology of Cambridgeshire.—Mr. Whitaker has just published a list of works on the Geology of Cambridgeshire (printed for the Woodwardian Museum, Cambridge). It contains titles of 121 works; which is, however, a small list in comparison with those relating to other counties which he has prepared.

Discovery of a New Species of Fish of the Genus *Acrolepis* in the Millstone Grit of Yorkshire.—At the monthly meeting of the Manchester Geological Society, held on the 27th of January last, Mr. John Aitken, F.G.S., of Bacup, exhibited and described a number of very fine specimens of fish of the genus *Acrolepis*, new to science, which he had obtained from the débris brought out in excavating a tunnel through Wadsworth Moor, in the neighbourhood of Halifax, in a bed of fine black shale, separating the third from the fourth or Kinder Scout Grit,—the principal specimens having been obtained from nodular concretions which abound in the shales at this horizon.

The specimens comprise two nearly perfect heads (in the jaw of one a tooth is exhibited *in situ*), and several parts of the body illustrating the form and structure of the fish, amongst which are remains of two or three fin rays. The scales and head-plates are beautifully ornamented and covered with a fine enamel,—the former being rhomboidal in form, and profusely sculptured, having a number of distinct waving ridges and furrows traversing them in the direction of their longest axis, varying in number according to the position they occupied on the body of the fish, the ridges having a strong tendency to bifurcate, and not unfrequently to further subdivide into two or three branches, these often again converging and becoming re-united.

The genus *Acrolepis* has been figured and described by Professors Agassiz, McCoy, and King, the specimens having, with the exception of that by McCoy, been obtained from the Magnesian Limestone of this country and Germany. The specimens exhibited have, however, much larger scales, and differ in the style of ornamentation, as well as in many other essential particulars, from any of the figures referred to, leaving no doubt as to their constituting a new species of this rare fish. The discovery also carries this genus into a new horizon, which has previously been considered as almost barren ground: it is now known to be co-extensive with the Carboniferous system, ranging from the Mountain Limestone, through the Millstone Grit and Coal-measures, into the Permian formation, where it appears to have attained its maximum development; its remains having been found there more plentifully, both in our country and on the Continent, than in any of the older members of the system.

It is intended shortly to have the specimens described and figured, so that palæontologists may have an opportunity of judging of the value of the discovery.

In addition to the specimens above referred to, Mr. Aitken also exhibited remains of four or five other genera of fish, viz. *Acanthodes* sp., *Cladodus*, *Rhizodus* (*? Ctenacanthus*), and *Palæoniscus*, together with a considerable variety of other fossils, all from the same locality.

THE
GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE II. VOL. I.

No. V.—MAY, 1874.

ORIGINAL ARTICLES.

I.—THE ELEVATED SHELL-BEARING GRAVELS NEAR DUBLIN.

By the REV. MAXWELL CLOSE, M.A. F.G.S.[1]

THE elevated Drift deposits near Dublin have been brought under the notice of the Society by other observers. The late Mr. John Kelly has described in our Journal (vol. vi. p. 133) part of the gravels which form the subject of this paper; including the collection at Caldbeck Castle, 1300 feet above the sea. I have already mentioned before the Society (in 1867) the fact of having found marine shells in the Pleistocene gravels near Dublin, at heights of 1000 and 1200 feet above the present sea-level;[2] but I did not wish to offer a paper on the subject until I had collected what might seem sufficient materials for one. These shells are not only in a very fragmentary condition, but also scarce, so that they easily escape notice; and it is necessary to pay several visits, at sufficient intervals, to the few places where the shells are accessible, in order to obtain from thence even a limited collection of determinable species.

The gravels now in question belong to the "limestone gravel" of Ireland, and occur on the sides, or in the immediate vicinity, of the hill mass, the best known of whose prominences is named the Three-Rock Mountain—part of the N.E. end of the Wexford, Wicklow, and Dublin granite range. Ballyedmonduff is on the S.E. side thereof, on the road leading from Stepaside to Glencullen. A little below, and N. of, the highest point of that road, on the E. side of the road, just opposite Ballyedmonduff House, and at the elevation of just 1000 feet, is a gravel-pit which has yielded the shells given below. The distinctly-shaped mound, or mamelon, in which the pit is dug, is chiefly composed of clean stratified gravel and sand; it is part of a great collection of Drift which extends into the S.E., or Ballyedmonduff, bosom of the above-mentioned hill mass, and over the slight *col* at the highest point of the road leading to Glencullen; at which latter place it (the gravel) is of very considerable depth. In the said bosom the gravel maintains, at its upper edge, an elevation of about 1100 feet, for some distance; and spreads thinly over the hill-spur, marked on the map 1103 feet.

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[1] Read before the Royal Geological Society of Ireland.

[2] These are noticed in Jukes's "Manual of Geology, edited by Prof. Geikie; by Prof. Harkness in the GEOLOGICAL MAGAZINE. Vol. VI. p. 545; and in Sir C. Lyell's "Student's *Elements of Geology*," where, however, they are placed in the Co. *Wexford, and in the Pliocene formation.*

Shells at Ballyedmonduff, 1000 feet.—*Trophon muricatus* C, *Fusus*? (part of columella), *Turritella communis* CN, *Ostrea edulis* C, *Pecten* (two species), *Cardium edule*, *C. echinatum*, *Astarte compressa* CN, *A. elliptica* CN, *A. sulcata* CN, *Cyprina Islandica* CN, *Artemis lincta* CN, *Venus striatula*, *V. casina* C, *Lutraria elliptica*, *Mactra stultorum*?, *Tellina*?, *Mya truncata*? CN, *Pholas crispata* C, *Balanus balanoides* CN, *Small shell-boring Annelid* (perforations of).

The species, as also those named below, were determined by Mr. W. H. Baily and Dr. Carte. Those marked C are characteristic of the Celtic province of marine fauna (*Venus casina* is thus marked, although occurring exceptionally in the Mediterranean; as Edward Forbes believed it must have attained access thereto during the Glacial submergence). Those distinguished with CN are characteristic of Celtic and Northern European seas; or of the northern part of the Celtic area.

The remains of the house called Caldbeck Castle stand westward of the Three Rocks, on the *col* above Ticknock, which connects Kilmashogue Mountain with the rest of the said hill mass. About one furlong S. of the ruins is a pit, in clean gravel and sand, at the elevation of a little over 1,200 feet (slightly higher than the shell-bearing gravels near Macclesfield, described by Mr. R. D. Darbishire, F.G.S.,[1] Memoirs of Lit. and Phil. Soc. Manchester, vol. iii. 1868), which has yielded the following species.

Shells near Caldbeck Castle, 1200 feet.—*Fusus*? (part of columella), *Cardium echinatum*, *Cyprina Islandica* CN, *Venus striatula*, *V. casina*? C, *Mactra stultorum*, *Small shell-boring Annelid* (perforations of).

A little below, towards the S.W., in the bosom between the Kilmashogue and Tibradden hill spurs, *Cyprina Islandica* and other shell fragments can be found near the stream, at just 1000 feet. In the Killakee valley running up between Tibradden Hill and Killakee there is an immense irregular accumulation of Drift. In two gravel-pits near the wood where the Ballybrack road enters that valley, and at the height of 850 feet, were found, among other shell fragments, portions of *Cyprina Islandica* and *Cardium echinatum*. And near the head of that valley, beside the road, among some trees, and not far from where the military road passes, at the height of just 1200 feet, there is a pit which yielded a few fragments, of which only *Cyprina Islandica* and *Astarte elliptica* are recognizable. And finally, a little below, and S.E. of, the summit of Montpelier Hill, at the elevation of a little over 1200 feet, there is a long-disused and much grass-grown gravel-pit, in which one indeterminable shell fragment was found. This pit is four and a half miles from that first mentioned.

It is to be observed that, though all the above individual species *live now* in the neighbouring seas, yet, as a group, they present a *rather more boreal facies* than those of the present coasts, and than those of the low gravels, as a group (see paper by Prof. Oldham, Journ. Geol. Soc. Dublin, vol. iii. p. 131), and a decidedly less northern *facies* than the much larger collection of Drift shells from Moel Tryfaen, at 1360 feet elevation. However, it would be scarcely prudent to found any argument on the limited induction that we have been able to make. Two other points seem worthy of notice, though they may be but accidental: viz. that of *Cardium edule*, which occurs so frequently in the gravels at lower elevations, near Dublin, only one fragment has yet been recognized in the higher accumulations; and also, that but three univalves have been found, although shells of that class must be generally better able, than others, to withstand rough usage, and therefore more capable of handing down determinable fragments. Pieces of *Cyprina Islandica* are the most common, evidently on account of the thickness and strength of that shell.

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[1] *See* Geol. Mag., 1865, Vol. II. p. 293, with table of shells.

What then is indicated by the occurrence of marine Drift shells in those elevated situations in our neighbourhood? Not as much as might, perhaps, be supposed on first thoughts. We did not need their presence to assure us that the sorting and stratification of those elevated gravels and sands was effected by the sea; for, as Mr. Kelly has pointed out in his paper, it is utterly impossible to refer that to any other agent. And, moreover, those shells do not give us any information as to the character of the marine fauna of this district when the sea covered it so deeply. The gravel, etc., in which they occur is "limestone gravel" (with a slight sprinkling of granite stones), resting on granite hills; this has been carried thither from elsewhere; and the smashed condition of the shells, and the fact that those fragments, which are large enough to show it, are often well scratched, like many of the pebbles among which they lie, lead to the conclusion that those fragments form, as it were, part of the gravel and have been carried thither along with it, and that, therefore, the animals did not live and die where their remains are now found. (It would seem from the descriptions, especially by Mr. D. Mackintosh, F.G.S., of the Moel Tryfaen gravels and shells, that the same has been the case with the Drift shells of that place.) This conclusion is strengthened by the consideration that, when the sea was up at the level of the site of Caldbeck Castle, the ground would fall steeply down from the very shore-line in all directions to a great depth; and several at least of the above shells would be without sufficient platform, or suitable habitat, for their subsistence.

But how were the limestone gravels and the shells carried to their present positions on the granite hills? Let us note that only a very small proportion of the gravel stones exhibit signs of water-rolling; they are generally subangular; many are greatly scratched (these occur more usually in the upper parts of the gravel), and some are quite angular. Again, at Caldbeck Castle, the nearest part of the limestone ground is 2¾ miles distant, and 900 feet lower down; and at Ballyedmonduff pit the nearest part is 4½ miles distant, and 800 feet lower down; *yet the proportion* of limestone and other foreign *pebbles, etc., in the gravel at those places* is at least 99 per cent. It seems utterly impossible that that gravel could have been swept thither by water, along the surface of the ground, for at least those distances, and up-hill too, without having its pebbles nearly all rounded, and without picking up vastly more than one per cent. of granite stones. Again, at Ballyedmonduff pit there is, in one part of the large irregular excavation, and in the upper part of the section, a mass of earthy clay packed with blocks of limestone and grit, some as large as a man's head, and all greatly scratched; this looks almost exactly like true Boulder-clay (it probably belongs to the Upper Boulder-clay), and it overlies fine gravel and sand (all this is now much obscured by some trees having fallen and torn down the pit escarpment). Any rush of water that could have carried those stones along bodily, without rolling them, could not have deposited the fine materials on which they lie, and must have swept away those fine materials, if they had been already there. Since rushing water is out of the question, as the transporting agent, and also, as will be generally conceded, land-ice, for somewhat similar reasons, we seem compelled to believe, as Mr. Kelly did, that the gravels in question have been transported by floating-ice to their present situations (apparently from a north-westerly direction). The blocks of local granite, weighing sometimes up to 20 tons, which usually lie on the top of the (limestone) gravel, in places to which they could not have fallen or rolled, must have been left there by floating-ice; but this may have been local and more immediately connected with the hills.

The upper limits of these gravels are clearly not raised beaches. Yet on the south-east side of the Three-Rock Mountain, in the Ballyedmonduff bosom, there is an approach to a horizontal upper boundary, at the height of about 1100 feet, extending for about a mile; and about Caldbeck Castle and the head of Killakee valley, on the other side of the hill mass, a less near approach to such a boundary, at 1200 to 1300 feet, extending for two or three miles. Of course the upper limit of the gravel, as worthy the title of a deposit, does not necessarily indicate the greatest depth of the submergence in the glacial sea. Above that limit many pieces of foreign material can be found, almost to the summit of the Two-Rock Mountain, at the height of about 1760 feet.

As to the correlation of these high-level gravels with those on the low grounds—it seems impossible, at present, to ascertain their *precise* relations, from direct observation. Speaking roughly, they both evidently belong to the same formation, viz. the Pleistocene "middle sands and gravels," lying below the Upper, and above the true or Lower Boulder-clay. But, considering the most probable mode of transport, and the fact that the submergence of the low grounds must have begun sooner and ended later than that of the high grounds, we may perhaps conclude more definitely that the elevated gravels are contemporaneous with some of the middle parts of the low gravels.

Recapitulation (in different order).—1. The elevated gravels are *[illegible]eistocene,* and probably contemporaneous with some of the middle *[illegible]ts of the low*-level gravels. 2. They have been carried to their present position by floating-ice. 3. The contained marine shells have been brought along with the gravel. 4. Therefore the animals to which the shells belonged lived and died somewhere else, towards the northwest, and *that* very possibly before the time when the sea was deep enough to deposit the elevated gravels. 5. The shells, as a group, if we may venture to judge from so small a collection, point to rather more boreal marine conditions than now obtain in this region; although they are all to be found now inhabiting the neighbouring seas.

II.—Descriptions of New Fossils from the Devonian Formation of Canada.

By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E.;
Professor of Natural History in University College, Toronto.

(*Concluded from page* 163.)

(PLATE IX.)

Fenestella magnifica, Nicholson, Pl. IX. Fig. 22.

Polyzoary forming a flattened expansion of unknown but apparently considerable size. Branches almost perfectly straight, bifurcating at intervals of from one quarter of an inch to one inch, nearly parallel, united by straight transverse dissepiments, subangular or obtusely carinated, and closely striated on the noncelluliferous side. About four branches in the space of three lines, measured across the frond. Dissepiments about equalling the branches in diameter, usually placed at intervals of from one line to one-tenth of an inch apart. Fenestrules oblong, rectangular, nearly equal, from one line to one-tenth of an inch in length by two-thirds of a line in width; nine fenestrules in one inch measured vertically, twelve in the same space measured diagonally. The fenestrules of contiguous rows nearly, but not quite, at the same level. Celluliferous face unknown.

This species (Fig. 22) is most nearly allied to *Fenestella laxa*, Phillips, from the Carboniferous and Devonian Rocks of Britain; but it is readily distinguished by the regular dimensions of the fenestrules, their rectangular shape, and their much smaller size. (The fenestrules in *F. laxa* are from two to four times as large as those of *F. magnifica.*) From *Polypora* (*Gorgonia*) *ripisteria*, Goldfuss, the present species is separated by its rectangular, not oval, fenestrules, the much greater proportionate and absolute width of the fenestrules, and the straight, not flexuous, branches.

I have only seen a single specimen of *F. magnifica*, and that only exhibits the reverse side of the cœnœcium; but the general characters of the frond are so distinctive, that I have no hesitation in founding a distinct species for its reception.

Locality and Formation.—Corniferous Limestone, Port Colborne.

Fenestella marginalis, Nicholson, Pl. IX. Fig. 23.

Polyzoary forming a fan-shaped expansion, of unknown dimensions. Branches straight, nearly parallel, about four in the space of two lines; dissepiments exceedingly narrow, not more than one-hundredth of an inch in width, slightly expanded at their points of junction with the branches, quite straight, and separated from one another by intervals of one line, sub-alternate in contiguous rows. No cells upon the dissepiments. Fenestrules oblong, regularly rectangular, nearly twice as long as wide (nearly one line in length and less than half a line in width); three fenestrules in a quarter of an inch measured vertically, and five in the same space measured transversely. Two marginal rows of large flask-shaped cells, between which are two or sometimes three rows of minute elongated cells, which probably occupied a central keel. Four of the large marginal cells to the length of a fenestrule, and one opposite the origin of each dissepiment.

As in the case of the preceding species, I have only a single example of this species; but its characters are so peculiar that I have no doubt as to its specific distinctness. Our specimen is one exhibiting the back of the polyzoary, but the outer striated non-celluliferous layer has been denuded, and the proximal ends of the cells are thus brought into view. (Fig. 23.)

In its general form, *F. marginalis* is clearly a genuine *Fenestella*, as shown by the straight branches, the distinct straight non-celluliferous dissepiments, the rectangular fenestrules, and its possession of a row of large cells on each side of each branch. This last character separates it from *Polypora*, and the others distinguish it from *Retepora*. The specimen does not enable me to affirm with certainty that the two marginal rows of cells were separated by a median keel; but it appears highly probable that this was the case. In the genus, or sub-genus, *Fenestrellina*, D'Orbigny, the mesial keel, separating the two rows of large lateral cells, carries a central row of minute cells. In *F. marginalis*, however, the space between the lateral rows of cells carries a series of minute crowded cells, which are arranged in two or sometimes in three alternating rows; so that the central keel, if present, must have exhibited the openings of two or three rows of cells. This character, so far as I am aware, has not hitherto been noticed in any species of *Fenestella*, except *F. rigidula*, McCoy, and it may, perhaps, afford a ground of sub-generic distinction.

In its general form, *F. marginalis* exhibits some resemblance to *F. magnifica*, but its dimensions are much smaller. It possesses four branches in a space of two lines, and five fenestrules in three lines measured transversely, whilst the dissepiments are exceedingly thin, and the length of the fenestrules is nearly double the width. In the latter species, on the other hand, there are three branches in a space of two lines, and about three fenestrules in three lines measured transversely or diagonally, whilst the dissepiments are about as thick as the branches, and the fenestrules are only slightly longer than wide.

Locality and Formation.—Corniferous Limestone, Port Colborne.

FENESTELLA FILIFORMIS, Nicholson, Pl. IX. Fig. 24.

Polyzoary exceedingly delicate, composed of parallel, extremely narrow branches, about fifteen or sixteen of which occupy the space of a quarter of an inch. Dissepiments thread-like, narrower than the branches, expanded at their points of junction with the branches, separated by intervals of about one-tenth of a line. Fenestrules one-third wider than long, rectangular or transversely oblong, twenty-four in the space of one-quarter of an inch measured longitudinally, and about fifteen in the same space measured transversely. Celluliferous aspect unknown.

I have only fragments of this species, and none of these show the celluliferous aspect; but the proportions of the polyzoary are so entirely distinct from all other previously recorded forms, that no question can be entertained as to its being really new. It is very readily distinguished by its filiform and closely-set branches, by the unusual character that the fenestrules are wider than long to a marked extent, and by the extraordinarily large number of fenestrules in a given space measured vertically.

Locality and Formation.—Corniferous Limestone, Lot 6, Con. 1, Wainfleet.

SPIRORBIS ARKONENSIS, Nicholson, Pl. IX. Fig. 25 *b* and *c*.

Tube minute, sinistral or dextral, of two turns, rounded, and somewhat globular, owing to the elevation and large size of the last turn. Aperture circular, usually turned upwards. Diameter of the entire spiral about a third of a line, never exceeding half a line. Surface marked with numerous, very close-set, thread-like, transverse annulations or ridges, which are not separated by more than their own width. A minute umbilicus is present.

I am unable to identify this little species with any previously recorded. It presents the peculiarity that individuals in other respects precisely similar (Fig. 25, *b* and *c*) are sometimes dextral, and at other times sinistral, the latter being the commonest upon the whole. The terminal portion of the tube is sometimes continued to open in the plane of the spiral, or at other times is non-adherent and slightly elevated above the surface. The species is very readily recognized by its minute size, and the characters of its surface ornamentation. It appears to be quite distinct from *S. angulatus*, Hall, which, so far as I am aware, is the only species before recorded from the Hamilton Formation.

S. Arkonensis is found in great abundance, generally associated with *S. omphalodes*, Goldfuss (Fig. 25, *a*), attached to the exterior of *Heliophyllum Halli, Cystiphyllum Americanum, Cystiphyllum vesiculosum, Spirifera mucronata*, and other Corals and Brachiopods of the Hamilton Group.

Locality and Formation.—Hamilton Formation, Bartlett's Mills, near Arkona, Township of Bosanquet.

ORTONIA INTERMEDIA, Nicholson, Pl. IX. Fig. 26.

Tube conical, straight or flexuous, attached by the whole of one surface to some foreign body. Length, when fully grown, from a line and a half to two lines; diameter of the aperture somewhat less than half a line. Surface marked with strong encircling, sometimes lamellose, annulations or ridges, of which there are about eight or ten in the space of one line near the mouth, but more than twice this number in the same space towards the closed end of the tube. Sometimes the annulations are extended into wing-like prolongations (Fig. 26, *b*) on the latero-inferior aspects of the fossil, and the tube is attached by these to the surface to which it is adherent; and in all cases they are more pronounced on the sides than the aspect opposite to the surface of attachment.

Ortonia intermedia is distinguished from the other species of the genus by good and easily recognized characters. Some examples, indeed, exhibit a structure which has not otherwise been clearly detected in this genus—namely, that the tube is made up of a succession of imbricating conical segments, the upper edges of which produce the encircling ridges or annulations. A somewhat similar structure is seen in *Cornulites* and *Conchicolites*; but in these genera the segments of the tube are *inversely* conical, in other words have their smaller ends directed towards the mouth of the tube. Hence in these genera the annulations of the tube are produced by the *lower* edges of the segments. In *Ortonia intermedia*, on the other hand, in some examples at any rate, the tube is composed of a series of short imbricating conical segments, the *larger* ends of which are directed towards the aperture; and it is, therefore, the *upper* edges of the segments which form the annulations.

The species to which *O. intermedia* is most nearly allied is *O. minor*, Nich.; but the tube is not so strongly bent towards its closed extremity; it is upon the whole a larger and more robust form; and the annulations are considerably more remote and stronger.

O. intermedia occurs attached to the exterior of various species of *Cystiphyllum* and *Heliophyllum*; and it is always strictly solitary, though three or four individuals often occur within a space of a few lines.

Locality and Formation.—Not uncommon in the Hamilton Formation, Bartlett's Mills, near Arkona, Township of Bosanquet.

EXPLANATION OF PLATE IX.

Fig. 16.—*Botryllopora socialis*, Nich. *a.* Portion of *Heliophyllum Halli* with a small group of discs adherent to it, of the natural size. *b.* A single disc enlarged. *c.* One of the radiating ridges enlarged to show the cells. From the Hamilton Group.

Fig. 17.—*Ceriopora (?) Hamiltonensis*, Nich. *a.* Portion of the stem, natural size, showing the mode of branching. *b.* Fragment enlarged, showing the form of the cells, and the tubular intercellular interspaces. From the Hamilton Group.

Fig. 18.—*Polypora pulchella*, Nich.; *a.* Fragment, natural size. *b.* Portion of the reverse magnified. *c.* Fragment from which the non-poriferous layer has been stripped off, showing the bases of the cells, enlarged. *d.* Cast of the inner surface, enlarged, showing the cell-mouths. From the Corniferous Limestone.

Fig. 19.—*a.* Fragment of the cast of *Polypora Halliana*, Prout, enlarged. *b.* Fragment of the cast of *Polypora tenella*, Nich., enlarged. Both from the Corniferous Limestone.

Fig. 20.—*Polypora tuberculata*, Nich. *a.* Fragment of the natural size. *b.* The

same enlarged. *a.* Portion of a branch still further enlarged. From the Hamilton Group.

FIG. 21.—*Retepora Phillipsi*, Nich. *a.* Fragment of the natural size. *b.* Fragment in which the outer non-celluliferous layer has been removed, showing the bases of the cells, enlarged. From the Corniferous Limestone.

FIG. 22.—*Fenestella magnifica*, Nich. *a.* Portion of the polyzoary, natural size. *b.* Fragment of the same, enlarged. From the Corniferous Limestone.

FIG. 23.—*Fenestella marginalis*, Nich. *a.* A fragment, of the natural size. *b.* A portion of the same, enlarged. *c.* A portion of a branch still further enlarged, viewed from behind, and showing the large marginal and the minute central cells. From the Corniferous Limestone.

FIG. 24.—*Fenestella filiformis*, Nich. *a.* Fragment, natural size. *b.* Portion of the same enlarged. From the Corniferous Limestone.

FIG. 25.—*a.* *Spirorbis omphalodes*, Goldfuss, of the natural size and enlarged. *b.* *Spirorbis Arkonensis*, Nich., of the natural size and enlarged. *c.* A dextral example of the same, enlarged. From the Hamilton Formation.

FIG. 26.—*Ortonia intermedia*, Nich. *a.* One of the tubes enlarged. *b.* Another example in which the annulations are greatly extended laterally, enlarged. From the Hamilton Formation.

III.—ON THE SUBSTITUTION OF ZINC FOR MAGNESIUM IN MINERALS.

By EDWARD T. HARDMAN, F.R.G.S.I.[1]

Of the Geol. Survey of Ireland, Associate of the Royal College of Science, Dublin.

IN the GEOLOGICAL MAGAZINE of last October[2] I have noticed the occurrence of zinc in small quantities in the White Limestone (Chalk) of the Co. Tyrone, and also in the overlying basalt. When that paper was read,[3] exception was taken to the latter part of it, on the ground that the metal in question had never been known to exist in rocks of igneous origin; but as my analysis seemed perfectly trustworthy, I saw no reason to modify it on the objections then put forward. Since then, whilst making an investigation—with a different object—on a specimen of basalt from another locality in the neighbourhood of that whence the one originally examined was obtained, I succeeded in again finding zinc in it; and I think it well to mention the fact now, as an *addendum* to, and as confirming my former statement.

The specimen was procured at a place called Curglasson, near Stewartstown, from the heart of a quarry by the roadside; being more than a mile north of the spot whence the basalt referred to in my former communication was obtained. The rock was carefully examined qualitatively for all the metals precipitable from an acid solution by sulphuretted hydrogen. Iron and alumina were then precipitated, and the filtrate examined with the utmost caution. On the addition of ammonium sulphide, a distinct white precipitate appeared. As it was probable that a little lime might have been brought down by a trace of carbonic acid in the re-agents, the precipitate was filtered off, re-dissolved in hydrochloric acid, and reprecipitated. (*a*) It was again re-dissolved, evaporated to dryness, and strongly ignited, to drive off ammonia, etc. A small quantity of the residue, *which was deliquescent,* was mixed with carbonate of soda, and exposed before the blowpipe on charcoal. The support became covered with the usual zinc oxide incrustation, which, treated with nitrate of cobalt, gave a vivid green. The fused bead and support were levigated with water in an agate mortar, when numerous spangles of white metal were seen, which, when treated with a drop of water very slightly acidulated with hydrochloric acid, dissolved with evolution of hydrogen. As the solution (*a*) could only contain zinc, with a trace of ferrous iron, and of lime, this experiment was conclusive.

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[1] This paper formed part of a communication read before the Royal Irish Academy, January 26, 1874.

[2] Vol. X. page 434.

[3] Before the Royal Geological Society of Ireland, June 11, 1873.

The above results were obtained with separate portions of the rock, treated in the following different ways :—

(1). The powdered rock was fused in a platinum crucible with carbonate of soda.

(2). The powdered rock was boiled in strong hydrochloric acid.

(3). The powdered rock was boiled in nitro-hydrochloric acid.

It is somewhat remarkable that only a trace of titanium was observed in this specimen.

In my former note on this subject, I endeavoured to account for the presence of zinc by the supposition that it existed as a distinct mineral, and pointed out the possibility of its being introduced by the infiltration of water; but subsequent examination and consideration has led me to what appears to be the true clue. Zinc is very closely allied to magnesium in characteristics and behaviour, both in the metallic state and in combination with other elements. In many points the resemblance is very strong;[1] their salts have a similar composition, and these, as well as the natural compounds, or minerals, are isomorphous.[2] Consequently, following the law of isomorphism, they should be mutually replaceable; and wherever we find the one in any quantity, we should expect to find the other encroaching on it. It is curious that while in most mineralogical treatises the interchangeability of the protoxides of iron, manganese, calcium, and magnesium is laid down, that of zinc with these, so far as I am aware, has not been yet shown,[3] and in the very few instances in which zinc is given as an accessory metal, its presence seems to be considered rather as an accidental circumstance, than as the result of any chemical law. In few cases has it been given in the composition of a mineral, unless when present in such quantity as to make a very serious item in the analyses, as in those of Automolite, or zinc spinel (20 to 35 per cent. of Zn 0), and Franklinite (17 per cent. Zn 0); while in most minerals traces of Mn, Fe, Mg, are constantly recorded as replacing part of the essential metals.

Believing, therefore, that zinc compounds might thus be calculated to occur in most magnesian rocks or minerals, I have tried several, and so far the result has almost exceeded my expectations, for in every single case the metal was proved. As yet I have merely satisfied myself with regard to its presence, reserving the quantitative determination until I shall have completed the testing of a number of specimens; but it may be worth while to mention the rocks and minerals already searched.

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[1] Fownes' Manual of Chemistry, 10th ed. p. 393; also Galloway's Qualitative Analysis, p. 49.

[2] *Supra cit.;* also Dana's Manual of Mineralogy, p. 74.

[3] Although in one or two cases implied.

1. *Granite.*—Wicklow and Wexford range variety:[1] from Graigue-na-spiddoge, near Carlow.—Obtained from heart of quarry: (*a*) A very coarse-grained light grey rock, porphyritic in parts, containing white mica, together with a dark greenish magnesian variety; also tourmaline. The portion taken for analysis was prepared in such a way as to contain a preponderance of mica, and four analyses of this were made in the wet, as well as others in the dry, way, ere I allowed myself to be perfectly satisfied as to the presence of zinc. The quantity of this was very small, as was of course to be expected. Traces of copper and lead were also noticed.

(*b.*) *Mica.*—After many searches at the same quarry, I was fortunate enough to find a mass of mica sufficiently large for analysis with the blowpipe. It was mostly white, but contained laminæ of green mica. About four grains were treated on charcoal before the blowpipe, with carbonate of soda. Two metals were reduced, which proved to be copper and zinc. The zinc spangles dissolved with rapid evolution of hydrogen in a barely acid solution of hydrochloric acid. The solution evaporated to dryness, moistened with nitrate of cobalt, and heated on charcoal, gave the characteristic green re-action.[2]

2. *Serpentine* (?).—A green soft steatitic rock from Garrarus Strand, near Tramore, Co. Waterford. This rock occurs among Silurian limestones and slates, near masses and dykes of felstone, etc. Some of the limestone can be distinctly seen to pass into Serpentine. Examined qualitatively for zinc: found it present in fair quantity, all the re-actions being most distinct.

This rock contains about 8 per cent. of water, and 11 per cent. of carbonic acid (CO_2).[3]

3. *Basalt.*—Already described.

4. *Black Mica.*—In a gneissose or granitic rock. Locality unknown. Specimen from Geological Survey collection.[4] The mica is perfectly black, and occurs in quantity in small flakes thickly massed together.

About four grains were treated at a time before the blowpipe with carbonate of soda. After fusion the mass yielded a notable quantity of copper, a very appreciable amount of zinc, and a trace of a metal which seemed to be lead. All the characteristic tests for zinc were answered very distinctly.

5. *Chlorite schist* (? *Talc schist*).—With inclosed grains of glauconite (?). From Geological Survey Collection. The examination with the blowpipe gave two metals, both in very appreciable

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[1] Leinster Granite.

[2] The zinc most probably occurs here in the dark magnesian mica.

[3] It is therefore not entirely metamorphosed.

[4] The specimens from the Survey Collection were obtained by the kind permission of Prof. Hull, F.R.S., Director of the Geological Survey of Ireland.

quantity, viz. copper and zinc. The zinc re-actions were very pronounced.

6. "*Mountain Leather.*"—Variety of asbestus. From Portlock's Collection, Geological Survey Museum, Dublin. Locality unknown; but associated with asbestus and other basaltic minerals from Antrim. Zinc very apparent, all the re-actions being perfectly unmistakable. A trace of lead (?) was also observed.

7. *Augite.*—Very large crystals in a trappean ash. Locality unknown. From Geological Survey Collection. About four or five grains of the powdered mineral, fused with carbonate of soda on charcoal, yielded a sufficiency of metal to identify with certainty. Besides zinc, copper was present. All the zinc re-actions were most distinct.

All the above minerals and rocks were selected at random, on account of containing, or being themselves, magnesian compounds, and they are numbered in the order in which they were examined, every one resulting in "a find." In many cases the examination by the blowpipe and its immediately connected wet tests was found to be amply sufficient to prove the presence of the metal; especially as from the comparatively large amount of the substance under investigation taken,—four or five grains,[1]—there was little possibility of error. But where the result was at all doubtful, it was confirmed by one or more analyses in the wet way.

The amount of zinc appeared to be most plentiful where the largest quantity of magnesium existed; but as I am as yet only concerned in proving the *presence* of the former metal in the above minerals, I am not now in a position to positively assert this; deferring the quantitative analyses until I have continued the investigation so far as to enable me to select the most typical examples for estimation. In the mean time these notes on the subject may not be without some interest, bearing as they do on a matter of much importance from a mineralogical as well as a chemical standpoint.

It may be thought that the zinc might as well be considered to replace the other members of the isomorphous group, which are known to occur in traces and occasionally in quantity in some of these minerals. But this would be a replacement of a replacing element; and I believe it is invariably considered that the accessory metal substitutes itself for part of the essential one. On this ground alone, all the minerals here referred to being strictly magnesian ones, the zinc must be regarded as replacing magnesium. At the same time I do not doubt that in other instances where there is no magnesium, it may be equally found to replace any of the other members. But when we remember the affinities of the two metals, it will hardly be considered a far-fetched notion to suppose, that were a preference possible, the zinc would associate itself with the magnesium, in the same way as some other metals act towards each other, notably the Platinic group; which possessing a very peculiar relation to one another independently of their isomorphism—which is not thorough—are nearly always found together.

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[1] This was rendered possible by the use of paraffin oil in the blowpipe lamp, by which a very large and hot flame was procured, capable of decomposing a much larger quantity of rock. For reductions, and where great heat is required in blowpipe *analysis, it will be found* most useful where gas is unattainable.

It will be seen that the majority of the minerals examined are species that are most often found in nature forming component parts of igneous rocks, while two rocks of that class are themselves included.

IV.—The Volcanic History of Ireland.

Being the Anniversary Address delivered to the Royal Geological Society of Ireland, February 11th, 1874.

By Professor Edward Hull, M.A., F.R.S., President;
Director Geological Survey of Ireland.

(*Concluded from page* 150.)

(PLATE X.)

Carboniferous Period.—The Lower Carboniferous rocks, both of the North of England, of Scotland, and of Ireland, afford examples of contemporaneous volcanic action of considerable intensity. The so-called "toad-stones" of Derbyshire, and the great sheets of melaphyre, porphyrite, and ashes of the central valley of Scotland, forming the Kilpatrick, Campsie, and Dalry Hills, appear to have been erupted over the bed of the same sea as that in which were poured out similar materials in County Limerick, forming the well-known Carboniferous volcanic rocks of "the Limerick Basin." These rocks have been already so fully described by several observers, that I shall confine myself to a very short description, such as is essential to the brief history of volcanic action which I am here endeavouring to draw up.[1]

The trap-rocks of the Limerick basin, ably described by Professor Apjohn, belong to at least two consecutive periods of eruption; both, however, included in the Carboniferous Limestone period, and are disposed in concentric sheets round a tract of Upper Limestone shale which occupies a district around Ballybrood. The "Lower trap-band" is more important and continuous than the Upper, and along with beds of ash and agglomerate is found in several tracts to the north and west of the band itself. In several spots both to the north and south of the "Lower trap-band," are isolated bosses of trap, such as those of Knockdirk, Carnanagh Fort, Cullon, and Maddyboy, which may be regarded as the old "necks" or volcanic throats, from which the sheets of trap and ashes have been erupted or blown out, but from which they are now disconnected by denudation.

As regards the composition of these rocks, notwithstanding the variety of names they have received, microscopic examination shows them to belong, with few exceptions, to that series of old augitic lavas usually called "melaphyres," which have undergone considerable alteration from their original condition. The base is for the most part a triclinic felspar, in which are inclosed crystals of augite, olivine, and magnetite, together with chlorite, which must be considered of secondary origin. While such is the character of the generality of these Lower Carboniferous lavas, there are occasional variations; and in the case of the rock of Knockdirk we find a highly silicated felstone forming apparently one of the old necks of eruption.

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[1] The composition of the Knockdirk trap is essentially so different from that of the other masses, that I suspect it to belong to an older period of eruption. See author's paper on "*The Microscopic Structure* of the Limerick Trap-rocks," Geological Magazine, *1873, Vol. X. p. 153, Pl. VIII.*

Another interesting volcanic district referable to this period lies at the entrance to Bantry Bay, amongst the rocks extending from Black Ball Head to Bear Island. They consist of slates, grits, and calcareous bands belonging to the "Carboniferous Slate" and "Yellow Sandstone" series of Sir R. Griffith. The volcanic rocks associated with these consist of contemporaneous and intrusive felstones, greenstones, with beds of ash, breccia, and agglomerate, and are ably described by Messrs. Kinahan and O'Kelly in the Memoirs of the Geological Survey.[1] Amongst these certain actual vents of eruption are recognized by the authors referred to; and owing to the variety of volcanic phenomena here exposed in the fine coast-sections,—the beds of felstone, porphyry, ashes, and breccias; the old volcanic necks filled sometimes with trap, sometimes with fragmental materials; and the dykes which range both through the igneous and sedimentary rocks,—this district offers most instructive materials to the student of the volcanic phenomena of Palæozoic times.

As the upper portion of the Carboniferous Slate series, which expands into such unusual proportions towards the south-west of Ireland, may, with some probability, be considered as partly the representative in time of the Carboniferous Limestone, it seems highly probable that the submarine volcanos of the south-west coast just described were in active operation at the same period as the earlier ones of the Limerick Basin, and these again contemporaneously with those of the centre of Scotland and the north of England; so that this portion of the bed of the ocean—swarming as it was with coralline, radiate, and molluscan life—was at this period frequently invaded by sheets of augitic lava poured forth from submarine vents; and by showers of ashes, stones, and bombs, shot forth and strewn by the currents of the sea.

With these events the history of the Palæozoic volcanic irruptions of our island closes; and we have to ascend through a long lapse of geological time, including the whole of the Mesozoic epoch, before we again meet with evidence of contemporaneous volcanic action in Ireland.

Tertiary Period.—After the volcanic fires had slumbered throughout so many ages, they again burst forth in the Tertiary period with unwonted intensity over the area now occupied by the N. E. of Ireland, extending thence to the west of Scotland and the Inner Hebrides. In our own island the area now occupied by these volcanic rocks may be taken at 2,200 to 2,300 square miles. Yet this area, large as it is, is but a fragment (though doubtless a large one) of the original surface covered by augitic lavas, which once stretched as far south as the mountain ranges of Slieve Croob or Mourne, and eastward as far as the Sperrin Mountains in the County of Derry.

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[1] Geol. Survey Map, Sheet 198, with "Explanations" to Sheets 197 and 198). *Also* Mr. Kinahan on "The Igneous Rocks of Berehaven," Journ. Geol. *Dublin*, vol. vii.

The volcanic rocks of the north-east of Ireland are clearly referable to three distinct periods of eruption—all, however, more recent than the Upper Chalk—and therefore referable to the Tertiary period. During the earliest of these periods, eruptions of highly silicated lavas, which have solidified into trachytes, rhyolites, and pitchstones, took place from several distinct vents—two of which, at least, have been determined. One of these is situated west of Hillsborough, amongst the Lower Silurian rocks, and the other amongst the hills north-east of the town of Antrim, at a distance of twenty miles from the former. At what precise period this eruption of trachytic lavas took place, we have no means of knowing; but as it preceded that of the overlying augitic lavas which we know to have been of Miocene age, it is probable that these oldest volcanos were in activity as far back as the Upper Eocene period. Thus it would appear that the volcanic fires burst forth contemporaneously over the north-east of Ireland, and the region of Mont Dore in Central France, where the eruptions have been shown by Lyell and Scrope to have taken place at this period. This earliest period of volcanic activity was followed by one of, we may suppose, prolonged repose, upon the close of which a second and more extended outburst of volcanic materials took place over the whole area, extending from the slopes of the Slieve Croob range northwards. The lavas of this period are essentially augitic, consisting of dark amygdaloidal basalts and dolerites often decomposed, and parted by bands of bole and red ochre, which were formed by decomposition of the upper surfaces of successive flows. The most southerly of the vents of this period seems to have been situated at Scrabo Hill, in Co. Down, on the south side of Belfast Lough, and many others, mostly hidden from view, are scattered over the surface of Co. Antrim. The sheets of lava poured forth from these vents in successive flows attained a thickness of 500 or 600 feet, and were accompanied by showers of ashes, after which there was a cessation of volcanic activity: and the second period came to a close.

It was during this period of repose that those remarkable and valuable beds of lithomarge and pisolitic iron-ore were formed, as I believe under the waters of a lake, or chain of lakes, several times larger than Lough Neagh. The streams which entered these lakes—strongly impregnated with iron—also carried down leaves and stems of plants which grew on the basaltic uplands along their shores. In other places plants actually grew over extensive lagoons, and beds of lignite were formed. The plants from these beds have been described by Professor Harkness, F.R.S.,[1] and more recently by Mr. W. H. Baily, from specimens obtained from the railway cutting of Ballypallidy,[1] by the late Mr. Du Noyer. The identity of these plants with those of Miocene age establishes the geological age of the basaltic lavas on which they repose, as also their coincidence in time with the basalts of Mull and the Inner Hebrides, first determined by the Duke of Argyle, with the assistance of the late Prof. E. Forbes.

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[1] *Brit. Assoc. Report*, 1856, p. 66.

At the close of this period of repose a new outburst of volcanic activity took place, and great sheets of augitic lavas were poured over the older beds, to a depth of 400 or 500 feet in some places. Amongst the old necks or vents belonging to this third period, probably those of Dunluce, filled with large bombs, and of Sleamish, an abrupt isolated mass of basalt rising above the surrounding country, may be identified; but the craters have entirely disappeared, and we can only recognize occasionally the truncated throats by which they communicated with the interior of the earth's crust.

The third period of volcanic activity seems to have been accompanied or followed by the production of immense numbers of nearly vertical dykes—filled with basalt—which traverse not only the older sheets, but the newer. The production of these dykes seems to have been the result of the final effort of the elastic gases and steam which are the motive forces in volcanic eruptions. In order to account for the existence of these dykes—which would occupy a considerable area if placed side by side—it is necessary to suppose a general inflation or bulging of the earth's crust in this region. Such an inflation would be accompanied by the formation of fissures, which, when filled in with molten lava from below, would, as it seems to me, result in the production of the dykes to which I have referred.

The whole of the volcanic operations here briefly described appear to have been subaerial. If submarine—as has often been supposed—we might expect to have found marine strata accompanying some of the beds of lava; but these are altogether absent, and the various bands of red bole can be regarded as nothing else than lava, or volcanic ash decomposed in presence of the atmosphere. The microscopic structure of some of the more compact beds of bole bears out this view.

It is very remarkable, considering the comparatively modern period of these volcanic phenomena, that, as far as we know, none of the original craters are to be found over the whole region. Here and there, indeed, we find the pipes or throats of the old volcanos, but the original craters have been obliterated. On the other hand, if we cross over to Central France, we find in the region of Mont Dore ancient craters in a remarkable state of preservation, and which were, apparently, contemporaneous with those of the north of Ireland. To the same period are also referable (in all probability) [illegible]me of the volcanic cones of Germany, Hungary, Transylvania; [illegible] it is unquestionable that the Miocene period was one of extra[illegible]ry volcanic activity over large European areas, in which the

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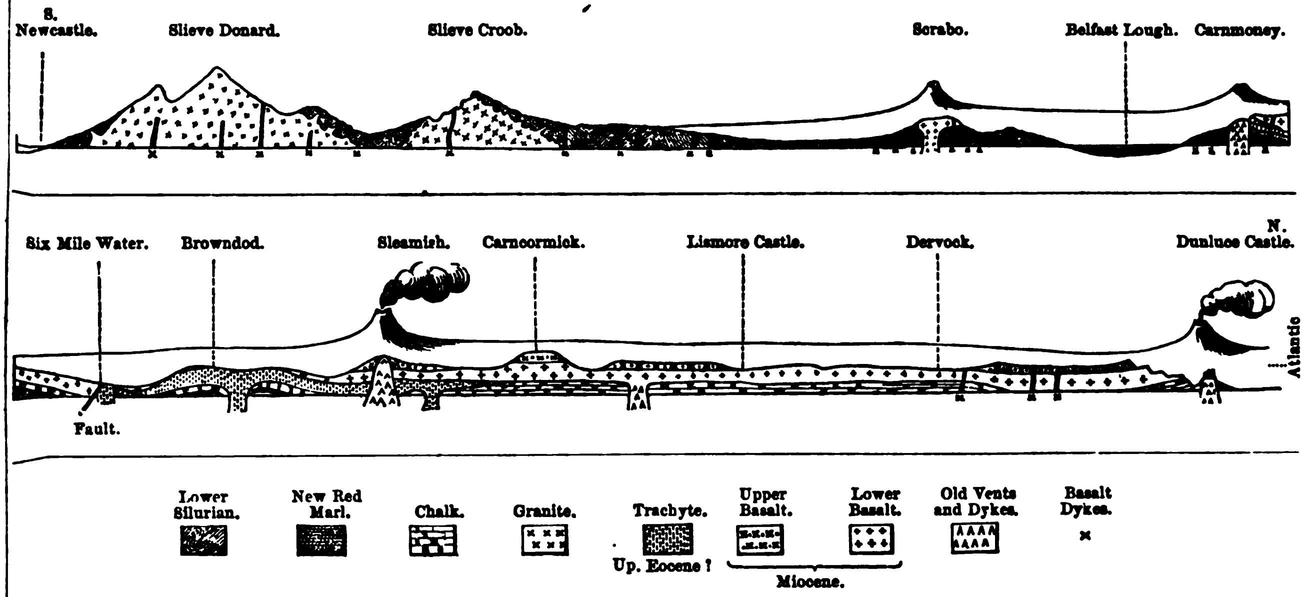
[1] *Quart. Journ.* Geol. Soc. Lond. vol. xxv. p. 357 (with plates).

Section from Slieve Donard to the Antrim Coast showing original and present positions of Volcanic Rocks.



(The older volcanos are represented as extinct; the newer as in action.)

To illustrate The Volcanic History of Ireland, by Prof. Hull, F.R.S.

original outline of the centres of eruption have been more or less preserved. With us, however, it is different, and it is plain that the north of Ireland and the western isles of Scotland have been subjected to agents of abrasion from which the other districts I have referred to have been to a great extent free.

It is to the various agents which were in operation chiefly during the Glacial epoch that we must, as it seems to me, refer the obliteration of the volcanic craters of the north of Ireland. These agents, indeed, were sufficiently numerous to exercise a most powerful effect in denuding the surface of the country. For, to the ordinary action of rain and rivers, must be added at one time the planing of an ice-sheet, and at another the levelling of the waves of the sea. The glaciated surfaces of the basaltic rocks at Fair Head and numerous other places attest the former presence of the one; while the beds of marine gravel, occurring especially in the adjoining district of Armagh, up to elevations of 200 or 300 feet, indicate the former presence of the other.

The amount of denudation in the north of Ireland since the period of the Miocene volcanos has indeed been enormous. Hundreds of vertical feet of basaltic rocks have been removed, considerable valleys, like those of Belfast Lough, Cushendall, and Bushmills, have been scooped out, and considerable tracts surrounding the basaltic region have been stripped of their former covering of trap.

Since the close of the Miocene period no volcanic outbursts have taken place over the area of the British Isles. The fires of that remarkable epoch have spent themselves here, and have retreated to Iceland on the one hand, and the borders of the Mediterranean on the other. Happily for us, we are not called on to witness the entombment of a Pompeii, or the destruction by a fiery torrent of a Catania. If these phenomena are to be witnessed, it must be at a distance from our own more fortunate Isles.

V.—Note on a Small Raised Estuarine Beach at Tramore Bay, Co. Waterford, showing Traces of several Oscillatory Movements during the Recent Period.

By Edward T. Hardman, F.R.G.S.I., F.C.S.[1]

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(PLATE XI.)

While spending a few days in the Autumn at Tramore, I chanced to meet with a well-marked example of recent alteration of shore-level; and as on subsequent examination I find it only partially noticed on the Six-inch Map, and not referred to at all on the published One-inch Sheet, or in the Memoir of the Geological Survey of the District, I thought of laying a short note on the subject before this Society.

The Bay of Tramore is separated by a long ridge of sand-hills known as the Burrow—chiefly of aërial origin—from an extensive *muddy estuarine* flat called the Backstrand, the result of the silt of

[1] *Read before* the Royal Geological Society of Ireland, December 9, 1873.

two or three streams flowing into and through it, at present of trifling size, but which must formerly have been of some importance as mud-carriers, as is shown by the dimensions of the old river-courses now filled by alluvium. These streams coalesce into one, that finds its way to the sea by a narrow passage called the Rinnashark. At various places around the estuary, and at heights varying from two to ten feet above high-water mark, layers of sand, clay, and gravel are found, resting on Boulder-clay, vegetable soil, or—as in one place—a thick layer of good peat bog; and containing numerous specimens of recent marine shells, chiefly the common cockle,—*Cardium edule*,—with *Turritella*, *Littorina*, *Modiola*, etc. Time did not permit of my making a very careful examination of the fossil contents of these beds. I was, however, able to trace the Raised Beach for about a mile on each side of the estuary. On the east side it is very well marked indeed as to configuration, forming a narrow stretch of low flat ground along the margin of the shore, and with shells tolerably abundant, these being also found at some little distance from the shore, in the sides of a ditch a field off. But on the west only a few isolated patches of shelly gravel were to be found; and the shape of the shore is not such as to suggest the existence of a raised beach. Yet of this there can be no question, as will be seen from the following details.

The first section seen on the west, at the north-eastern junction of Crobally Upper with Crobally Lower, and near the former mouth of one of the streams flowing into the bay, is as follows:

(See Plate XI. Fig. 1, p. 214.)	Ft.	In.	Ft.	In.
c. Mould, clay, etc. (artificial)	2	0		
b. Stratified sand containing fragments and whole shells of *Cardium edule*, *Turritella*, etc...	2	0	10	0
a. Boulder-clay, with Talus of recent sand, etc., in all	8	0		

The shelly bed here is somewhat variable in thickness—from six inches to two feet—and in level; but its height above present high-water mark is about ten feet.

Crossing the stream, and proceeding northwards along the coast for about 600 yards, we come to a place marked on the working Six-inch Map with the following note by Mr. W. L. Willson, who examined this district in the early days of the Survey:—"Layers of Cockle-shells (*in situ*) 2½ feet above present level of high-water, imbedded whole as if buried alive, in clayey drift." I could not find the deposit here alluded to, as it has been "improved off the face of the earth"; but a little to the east of the spot, in a new drain running from a sluice gate in the recently built Reclamation Wall, crossing the estuary from this point, I saw the following remarkable section (see Plate XI. Fig. 2, p. 214):—

	Ft.	In.
e. Clayey bed with broken Cockle-shells, about	0	8
d. Brown solid Peat	2	0
c. Clayey brown Sand	2	0
a. b. Brown clayey Boulder-clay, with cracks or pipes filled with blue stiff clay, to water's edge...	1	0
	5	8

The Cockle-bed was at a height of from two to three feet abov high-water mark. Had I not seen other sections having a direct bear ing on the above, and of some if not entire similarity to it, I shoul have been inclined to reject bed *c* as of artificial origin: but, a the sequel will show, there is a strong presumption that it is really *in situ.* In a drain along a new road, being the continuation of the wall to the westward, a somewhat similar section is seen:

(See Plate XI. Fig. 3, p. 214.)

	Ft.	In.
d. Soil, etc.	1	6
c. Peaty layer, becoming sandy inland	1	0
b. Bluish mud containing fragments of wood...	1	6
a. Sandy Boulder-clay, with cracks filled up with blue mud...	4	6
	8	

The shells are absent here, possibly because the former submer gence did not extend so far. The peaty layer undoubtedly corre sponds with the boggy bed of the last section.

Five hundred yards north of the sluice-gate, and close to th division of the Townlands, Ballinatin, and Drumcannon, Mr. Willsc has noted "Layers of Cockle-shells 2½ feet above high-water mark This has also disappeared.

The foregoing are the only traces to be found on the west of t estuary; but on crossing the Reclamation Dyke to the other side, t old beach becomes very apparent, and a little to the north, abo sixty yards from high-water mark, an excellent section is se (See Plate XI. Fig. 4, p. 214):

Section in Lissellan.

	Ft.	In.		Ft.
d. Vegetable soil and clay	1	0		
c. Dark sandy layer, rather peaty, containing abundantly at base layers of shells, Cockle, Mussel, Winkle, etc.	0	3	to	0
b. Muddy layer, thin and irregular, in pockets	0	2		
a. Gravelly brown Boulder-clay with irregular cracks containing blue mud strings	6	0	to	9
	7	5	to	9

The height of the shell-bed is here about nine or ten feet abo high-water mark, and it is found extending inland in a section e posed in a ditch, continuing into the next field.

A little south of this, and close to high-water mark, the same secti is seen; but here bed *c.* becomes very black, from the presence organic matter, in some places very peaty, and thickens to one fo Bed *b.* is sometimes a foot thick, and the height of the shell-bed seven feet above high-water mark.

Continuing southwards in Lissellan, the peaty layer is underl by a few thin layers of well-stratified gravel, full of shells, whi die out after a little distance. Further on along the shore the le of the peaty bed sinks gradually, and at last is covered by a disti layer of rudely-stratified gravel, in which a few shells are fou being evidently a shore deposit. This, which is about a foot thi and is covered with mould well clothed with grass, continues nearly half a mile, the height diminishing to about two feet, until gradually disappears under a thin bog connected with an alluvial flat. (See Plate XI. Fig. 5, p. 214.) This bog is itself covered by high-water of spring-tides.

I think there is sufficient resemblance between these sections and Figs. 2 and 3, to warrant us in referring them all to one horizon, and in believing the shells above the peat in Fig. 2 to be *in situ*, corresponding to the gravel-bed above the black bed in Lissellan.

North of the Wall (or of Section 4) the raised beach can be traced for about half a mile by its appearance, which is tolerably distinct. It seems to die out towards the head of the estuary.

Although this beach is of insignificant extent, it is of some interest on account of its recording several oscillations of surface as having occurred during Post-Glacial times; for it will be observed that from the sections three distinct land-surfaces and as many silt-beds can be identified. First and lowest comes the Boulder-clay, evidently denuded, perhaps after depression, and a deposit of mud and gravel, with shells laid on it—First Submergence. Then we have the land rising again, marked by a dark sandy bed full of vegetable matter (? old alluvium), with, in places, shells at the base, becoming in part peat bog—Second Land-Surface. Next comes a deposit of gravel, stratified, and in at least two places containing shells—Second Submergence. This is covered by quite recent bog passing into alluvium along the Keiloge River—Third Land-Surface. And the last is now subject to floods at spring-tides—showing that the Third Submergence has commenced.

With regard to this last, it may be mentioned that at the south-western corner of the estuary, close to the town, there is a partially-submerged and silt-covered bog,[1] which appears to be connected with an alluvial flat extending northwards. This bog has been buried for many years, for it was recorded on the Six-inch Working Map by Mr. Willson in the beginning of the Survey. At present there is no trace of it; but during the great storm of 1870 the strand was torn up and the bog laid bare. In the summer of that year I happened to be in the neighbourhood, and visiting the strand saw the bog where it was even then visible between high- and low-water mark. It appeared to have been covered by not more than six inches of sand, and was certainly *in situ*, and not the result of a quantity of bog having slipped, and spread over the sand. Had this been so, it must have been levelled and removed by the tidal action long before I saw it. The strand being now re-formed, there is none of the bog visible. It is possible that it is contemporaneous with the alluvial bog referred to above as capping the last gravel-bed in Section 5, at Lissellan; but that either because the land commenced to sink towards the south, or by reason of the slope of the ground, the latter has as yet only barely come within the influence of the water.

The subject of changes of level in estuaries as shown by the presence of alternating beds of peat or vegetable soil and silt, etc., dates from immediately before the deposition of the Upper Bunter Sandstone, and divides the Palæozoic rocks of south-western Germany into two independent mountain ranges, viz. the Black Forest and the Vosges. From thence northward during the Triassic and Jurassic epochs it remained as a narrow sea-gulf, connected to the south with the Franco-Swiss Jurassic sea, and to the east by a narrow strait between Langenbruck and the Lowenstein Hills with that of Swabia. Slowly the sea-bottom rose and formed, during the Cretaceous and in the beginning of the Tertiary period, a continent, of the inhabitants of which we have at present no knowledge. About the time when the deposition of the Calcaire Grossier indicated continental land on the south and east sides of the great Paris Basin, which was soon covered with freshwater lakes, this event was shortly afterwards followed by strata in similar lakes in what is now the Upper Rhine valley.

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[1] *The strand under which it lies* is covered totally at high-water.

From the Upper Saone, over the Jura and Alsace to near Heidelberg, we meet with small patches of light coloured limestone, everywhere filled with the same land and marsh shells, whose nearest analogues are still living in tropical Asia, and in smaller numbers in tropical America. Among them, but still very sparingly, some species begin to appear, which at present are confined to the Mediterranean district. Large Carnivora of the *Lophiodon* species, such as that described by Cuvier from Buxweiler in Alsace, lurked in the thickets on the lake-banks, whilst Crocodiles and bony-plated fish lived in the waters. Of the once abundant Flora nothing remains to us but a few fruits. We however cannot doubt but that it possessed the same preponderating tropical character as the shells. The Upper Rhine valley did not remain long under these conditions, the population of the freshwater lakes and their environs gradually changed, as is easily shown by a comparison of the shells and vertebrata of the older limestones of Buxweiler with those of the more recent beds at Brunnstadt in Alsace, and Kleinkems in Upper Baden. *Lophiodon* is replaced by *Anthracotherium*, more nearly resembling the pig, and along with it we find that most important mammal of the Paris Basin, made so famous by Cuvier, the pachydermatous *Palæotherium*. This typical form is remarkably interesting, standing as it does between the deteriorating forms of the modern Tapirs and the Horse, from which it differs so widely, and in south-western Germany it must have lived in great numbers, especially on the Swabian Hills. In the Middle and Lower Rheinthal the *Palæotherium* is nevertheless as sparingly represented as the *Lophiodon*. Luxuriant forests surrounded the morasses, the beloved home of the *Anthracotherium;* here also a Fan-palm, *Sabal major*, most nearly allied to the Swamp Palmetto of Southern North America, has left, at Lobsann near Weissenburg, numerous impressions of its graceful fans; whilst whole banks of the so-called Needle-coal testify to the abundance of *Coniferæ*.

Below this the Rhine plain sinks gradually from Delsberg far as Bingen and Kreuznach, and from the south-west the sea [illegible] *into the* extensive depression, and spread along the present bases of the Black Forest, Odenwald, the Vosges, and Haardt, as far as the Hundsruck Taunus and Spessarts, completely changing the previous contour. The banks of that inland sea, now the Mayence Basin, are everywhere still visible. Banks of oysters, covered with parasitical shells, corals, sea-acorns, heaped bones of the sea-cow, numberless sharks' teeth, called in the Pfalz "birds' tongues," are to be found near Delsberg and Lörrach, as also near Landau, Kreutznach, Geisenheim, and Wellenfurchen, often extending for miles, and they are also found in other places, such as Lahn and Heppenheim. Rich, however, as was the organic life developed in these seas (the number of species belonging to the different divisions of the animal kingdom hitherto found amounts to about 350), it cannot be compared with what we now find in tropical seas. The number of forms which are included in the European seas of the present day have markedly increased, though large thick shells are more sparse, and reef-building corals are entirely wanting. A part of this district did not remain long covered by the sea. As gradually as it sank it rose again, passing through all the stages from strongly saline brackish water to a freshwater lake. The animal remains which are found in the stratified beds of pure sea-sand and clay demonstrate this. First, the Oysters, which had begun to return, though smaller in form, vanish, followed by the *Veneridæ* and *Cerithiæ;* and only the tough Mussels, which still held their place in the almost entirely unfreshened parts of the eastern sea, along with pure freshwater species, are found in the upper beds of the Mayence Basin, in which myriads of the little marsh shell *Hydrobia* are found in the Limestone everywhere seen on the route from Mayence to Wiesbaden in the Salzbachthal.

It is in this same Limestone, on the opposite side of the Rhine, that the Vertebrate Fauna of Weissenau lies buried, the richness of which is only excelled by a few places in southern Europe, such as Pikermi near Athens, or Mount Lebéron in the south of France. Hornless Ruminants, Civet cats, and small Marsupials, as they appeared in the early times, still existed in great numbers. Instead of the *Palæotherium* we find Tapirs, and now, but rarely, that slender *Hippotherium,* whose dentition resembles the milk-teeth of the Horse so strongly as to bespeak its embryonic type. Instead of the *Anthracotherium,* we still only find the *Hyotherium,* a middle form between the Brazilian Musk-swine and the Asiatic *Babirussa.* A hornless Rhinoceros (*Aceratherium*) was already common. The smaller animal population, consisting of Martens, Moles, and Hamsters, shows a leaning, not without significance, towards the existing forms of the temperate zone. The constant progress in this direction is all the more striking when one compares the inland shells of the somewhat older limestone of Hochheim with those of Wiesbaden.

Thus we find:—

	Species of tropical Asiatic type.	Tropical and sub-tropical. America.	Canary Isles.	S. Europe.
At Hochheim...	11	16	9	21
At Wiesbaden..	3	3	2	17

From *thence downwards in* time we cannot follow the subsequent remodelling of the Rhine valley so well, for the coarse gravel of Eppelsheim and other places round Mayence and Worms shows a deteriorating and apparently far younger Vertebrate Fauna, differing so widely from that of the Hydrobian Limestone that it is impossible not to recognize the gap between the two. It is, however, only in the Mayence Basin that these gaps are visible. In France they appear to be so completely filled up by three successive Faunas that the gradual replacing of the older species by newer ones nearly related to them is demonstrated with the greatest certainty. Near Eppelsheim we find, instead of the hornless Ruminant *Dorcatherium*, and Stags, the south Asiatic Muntjaek (Prox), with simple bifurcate horns, along with Rhinoceroses with and without horns. These, however, do not long remain the largest forms in this wonderful Fauna, as they are soon surpassed by the gigantic Proboscidians, represented by *Dinotherium* and *Mastodon*. Swarms of *Hippotherium* lived in the woods; Stags on the prairies, often threatened by an immense carnivore (*Machairodus*), whose teeth exhibited the true type of the beast of prey on a scale yet more fearful than that of the Tiger; while the smaller predacious animals of the Civet-cat type had apparently to content themselves for food with the small vegetable feeders, which were for them but meagre booty.

The condition of the Upper Rheinthal during this time was still very different from what it is at present, for what is now the Kaiserstuhl, standing isolated in the plain, was then joined to the nearest Jurassic hills, and formed with them a watershed. On the south side of this the brooks carried Vosges pebbles as far as Delsberg in the Bernese Jura, in which the remains of *Dinotherium* are buried; while where the Birs now hastens northward to the Rhine, a river, which held the same course as the Rhine does now, brought Schwarzwald and Vosges stones, and some from the Langenbruck district of the Jura to Eppelsheim. From this time onward the gradual development of the valley becomes more difficult to follow. It appears as if the greater part of the strata of the older deposits, still remaining elsewhere till the beginning of the Diluvial period, have been partly carried away by denudation during the modelling of the older into the modern river-valley, and have partly been covered with newer pebbles to so great a height since this later modification, that traces of these old terraces can be recognized in but very few places.

The Rhine valley has no equivalent of the Fauna of Perrier in France and of Norwich in England, which contains, along with the latest Mastodon, the oldest true Elephant; neither has it the newer "Forest-beds," those old forests sunk under the sea, which extend forty miles out from the coast of Norfolk; nor the contemporary sands of St. Priest and St. Martial in France, where we find *Machairodus* along with the first typical Bears and Dogs, gigantic Stags and Red Deer, Stags of Virginian type with serrated horns bent inwards (*Cervus verticornis* of Boyd Dawkins), and Aurochs. We might, from their Flora, assign the well-known brown coal-beds r *Durkheim,* in the Rhine valley, to this period; but as yet they have not yielded any vertebrata nor shells; and there is also a gap between the Eppelsheim Fauna and that of the Middle Diluvial epoch not yet filled up.

When and how the dam in the Upper Rhine valley by Schaffhausen and Freiburg was destroyed, and how the river found a free course to the north, this is neither the time nor the place to decide; this however is certain, the remodelling of the present river-bed must have required an extraordinarily long time, and indeed was already in existence at the commencement of the Glacial epoch. Along almost the whole line from Basel to Bonn we meet, at a height ranging up to 150 metres above the present river, an old river-bed, which stretches, according to the contour of the land on either side, from three to six miles inland to the hill boundaries, which then formed the river-bank, and is still easily recognized as river-terraces. The lower bed consists of pebbles and sand, on which lies Hill-lōess. In the present river-valley, but at a much less height above the present water-level, we again find gravel, often more than thirty metres thick, and Valley-lōess. In this we first find, here and there, interstratified thin brown coal-beds, as, for example, at Steinbach near Baden-Baden, analogous to the beds at Utznach and Dürnten in Switzerland, and Imberg near Sonthofen in Bavaria. As far down as Heidelberg the gravel still contains Alpine pebbles and rolled moraine rubbish from the gigantic glaciers of the Rhine, as I have mentioned elsewhere. That the river must have required a very long time to cut out its channel to the lower gravel-bed, now forty metres above its present level, in addition to the 110 metres of the 150 metre-level mentioned above, requires no further explanation. It had, however, to dispose of an extra bulk of water in certain seasons, as it does now—a point to which I will return later.

This hypothesis of a long lapse of time agrees not only with the mechanical modelling work of the river, but also with the totally different character of the Fauna at the beginning and the end of the period, which I shall proceed to show immediately.

In the Rhine valley the larger Vertebrata are found, as in other river valleys, chiefly in bays formed by the debouchment of side-valleys into the chief one, as for example at Istein.

With regard to this latter view, the old Main delta, in the immediate neighbourhood of Hochheim, and from thence as far as Walluf, is known as the most celebrated and fertile finding-place for Diluvial Vertebrata on the whole Rhine, and in the sandpits by Mosbach near Biebrich, and also at Schierstein, they are exceedingly numerous. The pebbles form a veritable pattern card of all the rocks of the Main district. Along with the Sericit shale and Quartzite of the Taunus, and the Tertiary stones and Basalts of the neighbourhood of Frankfort, are found the Muschelkalk of the Kinzegthal and Bunter sandstone of the same district. Hornblende and Gneiss from Aschaffenburg, and, indeed, even the almost indestructible siliceous shale from the upper Main in the Fichtelgebirge, are not wanting. *The coarser gravels* contain the larger Vertebrata; the pebble-beds, interstratified with sand, the smaller bones and horns and the larger river-shells; and in the sand is a rich collection of land and freshwater shells. The Mosbach Fauna has already been made the subject of a learned paper by A. Braun and Herman von Meyer, and since then the interest felt in the German Diluvial formation has greatly increased. At present I can name 73 species of shells, and 24 Vertebrata, but I must be brief about them.

The greater part of the Mollusca are still living in the Main valley, more particularly in the upper part near and above Bamberg; others—viz. *Valvata naticina*, *Macrostoma*, and *Hyalina viridula*—are only found in the north-east and the north of Europe; *Pupa columella* still lives near St. Petersburg, in Lapland, and on the Gemmi; *Patula solaria* in the eastern Alps and the Silesian hills; others attain their southern limit at Frankfort. On the whole it is manifest that a much colder climate than that of the Mainzthal at the present day must have obtained at the time of the deposition of the Mosbach sands. The great difference visible between early times and now is presented yet more forcibly by the Vertebrata than by the shells. There we find, along with the Horse, Roe and Red Deer, Wild Boar, Badger, and Water-rat, still living in the neighbourhood, and the Beaver, the last specimen of which was killed near Mainz in the beginning of this century; the Elk and Auroch or *Urus*, which since the middle ages has been driven back to the marshy woods of northern Europe, Reindeer, now only living in Polar regions, Marmots, natives of the High Alps, all bearing witness to the Ice period. The gigantic Cave-bear, the Giant Stag (*Cervus megaceros*), possibly the mighty Schelch of the Nibelungen, were still among the beasts hunted during the oldest "Stone period," Elephant, Rhinoceros, and River-horse, all strange to the Europe of to-day. Elephants are represented by two species, one, the lesser, akin to the African *E. antiquus* (Falconer), and the larger one resembling the Asiatic, the Mammoth. The finding of the Mammoth, and also of the Rhinoceros of the Lõess, in perpetual ice in Siberia, covered with hair that adequately protected them from the northern winter, shows that they were not southern forms accidentally mixed with those belonging to the Arctic climate. The Hippopotamus only can be pressed into this view of the subject, inasmuch as Mosbach is its northern limit. But as this solitary animal might also have had a hairy covering, it is impossible to adduce it as any tenable ground for a contrary decision.

The association of Cave-bear, Mammoth, Reindeer, and Auroch all in one deposit at Mosbach, completely confutes the classification, by Lartet and Dupont, of the prehistoric times of the French and Belgian caves, into the Cave-bear, Mammoth, and Reindeer periods, and so forth—a theory which could not be established in the neighbouring Lahnthal, and which Boyd Dawkins has rightly abandoned for England. No trace of Man, not the simplest, rudest, splintered stone, has yet been found in the Mosbach sand; and yet the conditions e deposit prove to demonstration that these are precisely of the age as the flint-flake beds in the valleys of the Somme and the

Thames, etc., and on one as well as the other lies the Valley-löess, the Marl-mud of the Diluvial period, with which we must close our observations.

The fertility of the Nile valley is the only thing to which we can compare that of the Rhine, Main, Danube, and Rhone valleys, arising as it does from a kindred source, and this fertility already claims for this kind of hill country especial notice in the national economy. It is also important in the highest degree to the geologist as the result of the enormous successive periodical inundations of the Diluvial period. One absolute fact, easily calculated, may be deduced from it, viz. that in these times the Rhine at Strasburg carried 48 times as much water as it now does at its highest, and this will explain the enormous thickness of the mud. That this only relates to deposits at high-water levels is shown most clearly by the shells of the Lōess. They are almost entirely land-shells, and are certainly such as lived in the immediate vicinity of the river and its tributaries. High Alpine and hyperborean forms are found in them as well as in the Mosbach sand; but the true Alpine forms, such as *Clausilia gracilis* and *Helix pilosa*, are only found in the streams proceeding from the Alps, or in their great tributaries, generally spreading to the northwards. But the forms identical with those now living in the Main and Rhine valleys, so largely represented in the Löess, are never so common in the present high-water deposits; for example, the little amber shell, *Succinea oblonga*, now a rarity in the Main and Rhine valleys, is quite a common shell at St. Petersburg and Stockholm. The Vertebrata (15 species) are mostly the same as those in the Mosbach sand, but of Elephants we only have the Mammoth; the *Rhinoceros Merckii*, with the nose-*cloison* only half bony, is supplemented by the hairy Siberian *Rh. tichorhinus*, the nose-*cloison* of which is quite bony; the Hippopotamus is quite extinct, and Reindeer and Wapiti (*Cervus Canadensis*) are much more plentiful than at Mosbach. Of beasts of prey, we have here at first the Cave-lion and the Cave-hyæna, along with which, in the caves of the Lahnthal, are also found the Cave-wolf and Fox. It is most remarkable that of late our best osteologists have identified the Cave-hyæna with the South African *H. crocuta*. If this be so, it would be an anomaly without parallel in the history of Diluvial animals, indicating an emigration of a species of the Glacial period into a tropical climate, and for this reason this view must certainly be received with caution.

With the Lōess the Diluvial period closes. No deposit more recent contains any complete series of extinct species; and if a division is to be made anywhere between *Diluvial* and *Alluvial* periods, it must be made here.

We know that Man must have lived at that time, and that, scantily fed and roughly clothed, he waged war with the giant beasts of the olden time, over whom he remained the victor through the intellectual superiority which separates him from the nearest and most highly-gifted animals.

II.—THE OLD RHINE VALLEY. By DR. HIBBERT, F.R.S.

THE physical structure of the Old Rhine Valley is treated of by Dr. Hibbert in "The History of the Extinct Volcanos of the Basin of Neuwied," published more than 40 years ago,[1] in which he gives his views for inferring that the Rhine has not always followed its present course from south to north. The subject is noticed in the chapter on the state of the Rheinland at the commencement of the Tertiary epoch, illustrated by a sketch of the Tertiary geography of the Lower Rheinland, showing the division of the Upper and Lower Rhine basins. In consequence of a barrier of high land stretching across the present site of the Straits of Bingen, and thus filling up the small geographical space intervening between the chains of the Hundsruck and the Taunus, the marine basin from Mayence to Basle[2] had no connexion with the present channel of the Rhine from Bingen to Cologne, or farther north. Its waters flowed in a direction quite opposite to that they now maintain, being from *north* to *south*, while its southerly extremity was connected with the other marine basins of Europe by means of narrow channels. The first commencement of the drainage of the Lower Rhine was through a prolonged rent (due to some elevation of the Rheinland), which commenced near the present site of Bingen, and was continued in a northerly direction as far as that of Coblentz, where the freshwater basin of Neuwied commenced, which was of some extent, and considerably elevated above the level of the sea. The discharge from this basin was effected through a subsequent fissure of disruption, gradually widened and deepened, by which the water from the ancient lake of Neuwied was conveyed to the then extensive lower freshwater basin of Cologne, which overflow, in part of its course north of Andernach, must have been originally precipitated in the form of a cataract. Into the inquiry, whether a still lower freshwater expanse occupied the site of the lower flats of Holland, extending even to the shores of England, or into what sea the ultimate drainage of this chain of lakes was conducted, Dr. Hibbert does not enter, as being beyond the limits of his memoir.

It is thus seen that the Hundsruck and Taunus were the dividing range from which, at an early period, the streams were directed north and south, and the inversion of the current of the basin of the Upper Rhine was subsequently effected by the last elevation of the European Alps, which was the most considerable in the vicinity of the lake of Constance, and effected a change in the level of all the districts along the valley of the Rhine extending from Basle to Bingen, and perhaps even beyond the ancient barrier of Bingen, as far as the basins of Neuwied and Cologne, so that a continuous declivity was thus formed along the united courses of the Upper and Lower Rhine.

In short, says Dr. Hibbert, the sum of the change effected by the elevation of the Alps was as follows:—The waters of the upper freshwater basin of the Rhine, which had originally flowed from the present site of Mayence to Basle, in a direction *north* and *south*, towards the great inland sea of Europe, must now have suddenly changed their course from *south* to *north*, and, in escaping across the barrier of Bingen, where a cataract of the most formidable and overwhelming character must have been formed, would eventually press forwards towards the inferior basins of Neuwied and Cologne, and thence to the ocean, which then covered the present flats of Holland.

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[1] London, 1832.

[2] *M. Boue considers* this a marine basin of an early Tertiary period.

J. M.

III.—A COMPARISON OF THE LOWER EOCENE OF BELGIUM AND ENGLAND WITH THAT OF THE PARIS BASIN. By M. HÉBERT. (Ann. Scien. Géologiques, vol. iv. art. 4.)

IN this paper M. Hébert substantiates the opinion which he has long held as to the position and succession of the Lower Eocene strata in the above-named areas, and which is not quite in accordance with the views of other geologists. This subject has already been treated of abroad, by MM. D'Archaic, Raulin, and Dewalque; and in this country the valuable papers published in 1852 and 1855 by Mr. Prestwich and in 1866 by Mr. W. Whitaker are doubtless well known to students of Tertiary geology.

M. Hébert divides the Lower Eocene into Upper and Lower: the former, according to this author, being represented in all three countries; whilst the lower is found only in France and Belgium, and is wanting in England.

The paper is divided into three parts, namely:—(1), the sands of Bracheux and their equivalents in Belgium and England; (2), the beds comprised between the sands of Bracheux and the Calcaire Grossier; and (3), the beds comprised between the sands of Bracheux and the Cretaceous series.

1.—The sands of Bracheux constitute the equivalent of the Lower Landénien of Dumont, and contain the following characteristic species, which are found in both deposits, namely:—*Panopæa Vaudini*, Desh., *Thracia Prestwichii*, Desh., *Pholadomya cuneata*, Sby., *Ph. Koninckii*, Nyst, *Cytherea fallax*, Desh., *Cyprina Morrisii*, Sby., *Cucullæa crassatina*, Desh., *Pecten breviauritus*, Desh., *Turritella bellovacina*, Desh., *Natica Deshayesiana*, Nyst. These sands present two distinct fossiliferous horizons, that of Bracheux, and that of Jonchery and of Châlons-sur-Vesle. The two beds are well shown at the hill of Brimont, where they are divided by a sandstone with vegetable impressions. At present, neither in Belgium nor elsewhere is there any representative of this upper zone. As to the lower horizon of Bracheux, it is not less apparent in England than in Belgium, being there represented by the Thanet sands.

Independently of *Ph. cuneata*, *Ph. Koninckii*, *Cyp. Morrisii*, *Cuc. crassatina*, cited above, and which are characteristic of the Thanet sands, M. Hébert has found at Bracheux and Herne Bay *Psammobia Edwardsii*, Morr., and *Corbula Regulbiensis*, Morris; at Châlons-sur-Vesle and at Jonchery *Cytherea orbicularis*, Edw., and *Scalaria Bowerbankii*, *Morris* (*fide* Desh.); at Vaux-sous-Laon Pecten Prest-

wichii, Morris. Thus the palæontological relations are as strong between the sands of Bracheux and Thanet as between these and the Lower Landénien—a fact which is further attested by the lists of determined species given by Mr. Prestwich in 1852, and completed by Mr. Whitaker in 1866, and which are not found in beds higher than the Woolwich series.

2. (*a*). The Woolwich beds, Lignites of Soissons, and the Upper Landénien.

The identity of the fauna of the Lignites of Soissons and the Woolwich beds is complete, for in the Paris basin the fauna of the lignites has little relation with that of the Bracheux sands, or even with that of Jonchery, its nearest representative.

Mr. Whitaker cites (Quart. Journ. Geol. Soc. 1866, vol. xxii. p. 404) the following species as common to the Thanet sands and those of Woolwich:—*Corbula Arnouldi*, Nyst, *Cucullæa crassatina*, Lam., *Cyprina Morrisii*, Sby., *Cytherea orbicularis*, Edw., *Glycimeris rutupiensis*, Morr., *Nucula fragilis*, Desh., *Ostrea Bellovacina*, Lam., *Pectunculus terebratularis*, Lam., *Psammobia Edwardsii*, Morr., *Thracia oblata*, Sby. Two of these species are peculiar to the Woolwich series; others range higher, even to the London Clay; and some are characteristic of the Bracheux sands. Thus, from the succession of the mineral characters, which is the same in the two basins of England and France, from the identity of the faunas, and the relations which unite these faunas in England, we are acquainted with the complete succession of the phenomena, and there is no possibility of intercalating between the Bracheux sands and the lignites a deposit of a different nature, such as the Rilly limestone, notwithstanding the occurrence of a certain number of freshwater fossils common to the fauna of this limestone and that of Jonchery. The relations between the sands of Bracheux and the lignites is still more close in Belgium, so that Dumont has comprised them both in his *Système Landénien*. The Upper Landénien corresponds to the lignites of Soissons, for we there find the lignite beds and the principal fossils of this fauna.

2. (*b*). *The Clays of Yprés or Lower Yprésien.—London Clay.—Lacuna in the Paris Basin.—Emergence.—Oldhaven Beds.*

In Belgium the beds with *Cyrena cuneiformis* are directly covered by the Clay of Yprés, above which occur the glauconiferous sands with *Nummulites planulatus*, *Turritella edita*, and *T. hybrida*, and other fossils characteristic of the sands of Cuise. This clay, which is the perfect representative of the London Clay of England, is wanting in France, so that, as suggested by Dumont,[1] the French area was probably emerged during the formation of the Clays of Yprés and London. M. Hébert believes there are proofs of this emergence, and cites a pebble-bed at Vignolles, between the lignites and the Mercin sands, similar to those of Cuise, as a proof of an interruption in the deposition, or a lacuna; these pebbles having been produced during the return of the sea after an emersion of greater or less duration.

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[1] Bull. de l'Acad. Roy. de Belgique, t. xix.

The Oldhaven beds which underlie the London Clay are also wanting in the Paris basin, nor have they any representative in the Belgian area.

2. (*c*). *Upper Yprésien and Panisélien.—Sands of Cuise.—Lower Bagshot Sands.*

Above the Clay of Flanders (Lower Yprésien) are the argillaceous sands of the Upper Yprésien, terminated by fossiliferous beds which are characterized by species of the sands of Cuise, among which are *Num. planulatus*, Br.; *Turr. edita*, Sow.; *T. hybrida*, Desh.; *Crassatella propinqua*, Wat.; *Lucina squamula*, Desh. It is above the last beds with *Num. planulatus* that M. Hébert defines the upper limit of the Lower Eocene. There is also so much analogy both mineralogically and palæontologically between the Upper Yprésien and Panisélien, that he considers they ought to be united in a single group.

This reunion into a single stage of the Upper Yprésien and Panisélien, and the general correspondence with the part of the sands of Soissons which is superior to the lignites, that is, the sands of Cuise, has long since been made by Mr. Prestwich,[1] and although some doubt, and even difference of opinion, has been expressed by the Belgian geologists on this point, M. Hébert is of the same opinion as Mr. Prestwich.

Thus there are three great marine faunas, that of Bracheux, that of the London Clay, and that of the Cuise Sands; these, however, are not equally developed throughout the whole area, in consequence of the physical changes and oscillations of level which the surface has undergone during the whole period of their formation.

3. *Strata comprised between the Bracheux Sands and the Chalk.*

These are divided into different beds by M. Hébert, as shown in the Table below, commencing with the lowest or *Calcaire de Mons* reposing on the eroded surface of the White Chalk, and containing a rich marine fauna resembling, but differing from specifically, that of the *Calcaire grossier*, as well as some land and freshwater genera; its equivalent is wanting in the Paris basin. These beds underwent denudation prior to the deposition of the Lower Heersien sands, during which the conglomerates of Nemours and Rilly were formed.

The Lower Heersien sands of Belgium are considered to be equivalent to the Rilly sands of France, and the Upper Heersien sands as equal to the Rilly limestone, so rich in land and freshwater mollusca, and the strontian-bearing marls of Meudon. The overlying Heersien marine marls of Belgium are represented in the Paris basin by the conglomerate of Meudon and the marls of Dormans; these marls and all the underlying strata, according to M. Hébert, being below the Bracheux sands, and forming the lower group of the Lower Eocene strata.

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[1] Quart. Journ. Geol. Soc. vol. ii. 1855.

The following abstract gives M. Hébert's views respecting the correlation of the Lower Eocene strata, but which are not in accordance with other geologists, including Mr. Prestwich, whose opinion will be found in "Memoire sur la position géologique des sables et du calcaire lacustre de Rilly" (Marne), Bull. Soc. Géol. France, 2 se[illegible]r. tom. x. p. 300; and also "On the Structure of the Strata between the London Clay and the Chalk in the London and Hampshire Basin" (Quart. Journ. Geol. Soc. 1853, vol. 6, p. 252, and 185[illegible]5, vol. 8, p. 255).

TABLE SHOWING THE SYNCHRONISM OF THE LOWER EOCENE IN THE BASINS OF PARIS, BELGIUM, AND ENGLAND.

		PARIS BASIN. Lower Calcaire Grossier.	BELGIUM. Bruxellien.	ENGLAND. Bracklesham.
LOWER EOCENE.	UPPER GROUP.	Sands with *Nummulites planulatus*	Panisélien	Lower Bagshot Sands.
		Sands without fossils	Upper Yprésien.	London Clay.
		Wanting	Clay of Ypres	Oldhaven Beds.
		Wanting	?	Woolwich Beds.
		Plastic clay and Lignites	Upper Landénien	Thanet Beds.
		Sands of Bracheux	Lower Landénien	
		DENUDATION.	DENUDATION.	
	LOWER GROUP.	Marl of Dormans. Conglomerate of Meudon.	Heersien Marine Marls.	Wanting.
		Calcaire de Rilly, Strontian Marls of Meudon	Upper Heersien Sands.	
		Sands of Rilly	Lower Heersien Sands.	
		Poudingue de Nemours	Gap and Denudation	
		Wanting	Calcaire de Mons	

General remarks.—It is to be observed that during the period corresponding to the lower group of the preceding table, the basin of Paris as well as that of Belgium have undergone considerable denudation, so that the deposits of this period no longer exist as continuous strata, but only as outliers, as is shown by the limestone of Mons, the Heersien marl, the Rilly limestone, etc. These districts have been, during the early Tertiary period, the seat of oscillations, by which they have been alternately emerged and submerged. In the stationary interval of these movements deposits have taken place, but the incoming and retiring waters have carried off the greater portion of these deposits.

It had been the same at the close of the Cretaceous period. The different strata of the Upper Chalk (*Craie Supérieure*) posterior to the chalk of Meudon,—the chalk of Ciply, the Maestricht chalk, the pisolitic limestone, have been deposited and denuded under similar conditions to those above described. It is the cause of the numerous lacunæ that are observed, specially in the Paris basin, in the transition from the Cretaceous to the Tertiary period. M. Hébert points out that he has frequently shown how the sea, at the time of the Chalk of Meudon, the Upper Chalk and Lower Eocene, penetrated into the [illegible] basin by Belgium. The basin of Paris at these periods was a gulf dependent on the North Sea, the opening to which was between the Ardennes and the Boulonnais, already elevated above the sea level. It is thus natural, as we advance to the North Sea, that the lacunæ will be less. Belgium would furnish an intermediate term, and it is one of these terms that MM. Cornet and Briart have described. If we could explore the bottom of the North Sea, other terms would appear, for Belgium itself only increases the number of lacunæ.

But that which we call the North Sea is still only a gulf, having a communication with the ocean between the Shetland Isles and Norway; this gulf has undergone oscillations, and has perhaps been sometimes dry land. The complete continuity between these deposits cannot be well recognized, and it will be necessary to seek them in the great oceanic depressions.

However it may be, we conceive that certain species of the pisolitic limestone, the *Voluta robusta* for example, have continued to live in the North Sea, and returned to live in Belgium with new species at the period of the Mons limestone. The sea at this time, or a little after, penetrated into the Paris basin, leaving there some slight marine sediments, as those at the base of the Rilly sands; and after its departure, when the basin was transformed into a lake, some species, as *Cerithium inopinatum*, and a genus near to *Liotia*, lived in the brackish waters of the environs of Paris at the time when the eastern part of the basin became a lake, the lake of *Physa gigantea* and *Paludina aspersa.*

It is scarcely possible, in our present state of knowledge, to believe otherwise. We see the intimate relations there are between the Rilly limestone and that of Mons.

The basin of Mons has doubtless been emerged, and the limestone denuded before the incoming of the fresh water, which is shown by the older Heersien deposits. It remains to be proved if the fauna of these waters was similar to that of Rilly. These have been replaced by marine waters at a time which appears to correspond to the formation of the conglomerate of Meudon; and during the deposition of the white calcareous marls with *Pholadomya cuneata*, the white calcareous marls of Dormans without fossils would be deposited in the Paris basin.

It is only after this succession of deposits that the invasion of the sea of Bracheux occurred, with its sands and rolled pebbles, eroding the Heersien system and the more ancient deposits of the Mons basin, as the marls of Dormans, the Rilly limestone and the underlying beds in the Paris basin, and forming an horizon well defined, above which the stratification becomes clear and undoubted.

"In returning to this subject," says M. Hébert, "after an interval of twenty years, I can only confirm my former opinion respecting the Rilly limestone, and surely if the facts discovered during this period tend to prove I was then in error, I should readily recognize it, as I prefer to correct myself rather than be corrected by others; but before all I prefer to see truth established on a solid base, even if it *should be at my expense.*" J. M.

IV.—Brief Abstracts.

Davey, E. C. The "Sponge-Gravel" Beds at Coxwell, near Faringdon; with an Appendix on Cole's Pits. Paper contributed to the Newbury Field Club. 8vo. pp. 14. 19 photographic illustrations (18 of fossils). *Wantage*, [1874].

The "Sponge-Gravel" (Neocomian) crops out over a space of about a mile by a quarter of a mile, and is from 25 to 40 feet thick, forming a plateau based on Kimmeridge Clay, and capped in places by dark ironsand. The bed is a conglomerate of sand and fossils, mostly hardened by a ferruginous cement, and according to some authorities must have been accumulated in a deep clear sea, with currents; whilst others take it to have been deposited in a shallower and more sheltered sea.

There are two large and three small pits, some of which have been worked for a great time, being mentioned by Llwyd (who collected fossils from them) in 1698. In later times they have been the subject of much controversy, having been classified as Lower Greensand, Upper Greensand, and top Chalk (= Maestricht Chalk). The author thinks that Sharpe was led to take this last view from the abundance of Polyzoa; but he finds that of the half hundred species found at Coxwell, not half a dozen occur at Maestricht. He questions also whether there is a single species of Sponge common to the two beds, believing that the *Manon peziza* and *M. pulvinarium* of each are really distinct.

It is now allowed that these fossiliferous gravels belong to the Lower Greensand, or Upper Neocomian, and on these grounds: 1. Similarity with Lower Greensand, at Seend, Godalming, Upware, and Potton. 2. Presence of Lower Greensand Brachiopoda and Echinodermata. 3. Infraposition to the Lower Greensand ironsand of Furze Hill. 4. Dissimilarity from Upper Greensand, which is fairly developed in the neighbourhood.

The fossils are of two sorts—those that lived on the spot, and those derived from beds of Oolitic age. The latter can be distinguished by colour and condition, and they are chiefly the remains of vertebrates; the former are Sponges, Polyzoa, Echinoderms, and bivalve Molluscs, the absence of univalves being remarkable. The Sponges are most important, both as forming a large part of the gravel and from their good preservation. Sharpe names 16 species; but the author would eliminate from his list *Manon Faringdonense* and *Spongia Trigeris*, adding *Scyphia multidigitata*, Mich., and *Manon marginatum*, Goldf. (*Porospongia*, D'Orb.), and altering the name of *Manon pulvinarium*. *Chenendopora fungiformis* is also questionable. These 16 species differ much in form and size; some are funnel-shaped, some are single cylinders, some clusters of slender pipes, and some are solid, etc. Five characteristic sorts are illustrated, by descriptions of *Verticellites anastomosans*, *Tragos Faringdonensis*, *Manon marginatum*, *M. macropora*, and *M. porcatum*.

By the name of "Cole's Pits" is known a number of old over[illegible]wn excavations in sand and conglomerate (Neocomian), extending

over fourteen acres, which have been thought to have been the remains of habitations of an early British race, the largest being assigned to no less a person than "King Cole." The author shows that this view is untenable, and that the pits are only the remains of old workings for sandstone and ironstone, as remarked by Godwin-Austen.
W. W.

Walker, H. The Glacial Drifts of Muswell Hill and Finchley. With Map, Sections, and other Illustrations. pp. 24. *London*, [1874].

The author describes the various sections of gravel and Boulder-clay at Muswell Hill and Finchley. In accounting for the origin of these beds, he says that at Finchley we see the material of a moraine which has been extended beneath the sea from the land-ice, and distributed, by means other than that of moving water, over the sea bottom; and he also states that the original moraine-form may still be seen in the deposit. He adopts Mr. S. V. Wood's, jun., theory as to the direction whence the glacial clay was brought to Finchley, viz. from Lincolnshire, by a glacier probably 1000 feet thick, ploughing out materials from the Trias, Lias, Oolite, Neocomian, and Chalk, and which had its terminal moraine at Finchley, containing relics of most of these beds.
F. J. B.

REVIEWS.

Le Plésiosaurus dolichodeirus, Conyb., du Musée Teyler. Par T. C. Winkler. (Haarlem, 1873.)

THE Teyler Museum, so rich in fossils of all kinds, especially those from the lithographic stone of Bavaria, the Oeningen marls, and the Maestricht Chalk, has recently acquired a very fine specimen of the *Plesiosaurus dolichodeirus* from Lyme Regis, which has been carefully described and illustrated by the indefatigable curator, Dr. Winkler, in the third part of vol. iii. of the Archives of the Museum. This, the earliest noticed species, and upon which the genus was founded by Conybeare, was first discovered in a nearly entire state in 1824, and described and figured in the Geol. Trans. (2 ser. vol. ii.), and subsequently by Cuvier in the Ossements fossiles (tome v. 2me. partie). Previous to the discovery of this nearly entire skeleton, remains of the genus had been noticed by Conybeare and De la Beche in 1821 (Geol. Trans. 1 ser. vol. i.), and in the same work (2 ser. vol. i.).

Dr. Winkler's specimen presents the vertebral column entire, some bones of the skull, and the half of the lower jaw, the ribs broken and displaced, the anterior limbs nearly entire, many bones of the posterior limbs, and portions of bones of the pectoral arch and pelvis; the length is about 382 metres. There are 90 vertebræ, of which 38 are considered to be cervical,[1] 21 dorsal and lumbar, 2 sacral, and 26 caudal. The bones of the right fore-limb are nearly all in their natural position, the humerus is well preserved, the ulna and radius, short and broad, are succeeded by the proximal row of the carpus, which, according to Dr. Winkler, consists of *five* bones; the smallest or pisiform, of triangular form, is situated a little without and below the radius. Cuvier stated there were only four bones in the first row, and figured but three in the *Ossements fossiles* (tome v. p. 483, pl. xxxii. fig. 1).

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[1] Prof. Huxley remarks: "The cervical vertebræ may exceed forty in number, *though they are generally fewer;* and as none of the ribs appear to have been con-

Prof. Owen describes the carpus as consisting "of a double row of flat rounded discs,—the largest at the radial side of the wrist; the ulnar or hinder side appearing to have more unossified matter" (Palæontology, p. 248). Prof. Huxley states "there are six rounded carpal bones, arranged in two rows" (Manual, p. 214).

The Plesiosauria or Sauropterygia are essentially Mesozoic reptiles, but the genera have a more or less restricted range throughout that period. In the Trias are found *Nothosaurus*, *Pistosaurus*, *Conchiosaurus*, *Siniosaurus*, and *Placodus*, while *Pliosaurus* and *Plesiosaurus* are Post-Triassic, the former genus being chiefly confined to the Kimmeridge and Oxford Clays, the latter ranging from the Lias to the Chalk inclusive, and comprising many species. The first described species, *P. dolichodeirus*, is remarkable for the long neck and the smallness of the head in proportion to the body; *P. macrocephalus*, Conyb., has the head larger and the neck stronger; the *P. Hawkinsi*, Ow., has the snout shorter and more narrow; besides these three species there also occur in the Lias the *P. arcuatus*, Ow., *P. brachycephalus*, Ow., *P. macromus*, *P. rugosus*, *P. subtrigonus*, Ow., *P. Cramptoni*, Baily, *P. Etheridgii*, Huxl. In the Lower and Middle Oolite occur *P. carinatus*, *pentagonus*, and *trigonus*, Cuv., founded upon vertebræ, *P. erraticus*, Phil., *P. trochanterius*, Ow., *P. eurymerus*, *Oxoniensis*, *plicatus*, Phil., and in the Upper Oolite *P. affinis*, *dædicomus ellipsospondylus*, *trochanterius*, Ow., *P. carinatus*, *plicatus*, *validus*, Phil., and *P. brachyspondylus*, Ow., which, according to Dr. Winkler, is the same as *P. recentior* and *P. giganteus*, Conyb. The Plesiosaurs lived during the Cretaceous epoch; three species have been described by Prof. Owen, the *P. Bernardi*, *P. constrictus*, and *P. pachycomus;* and Dr. Harlan has also indicated a species from the Greensand of New Jersey. J. M.

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nected with the sternum, or if such connexion existed it cannot now be traced, it becomes difficult to distinguish between dorsal and cervical vertebræ, and one is obliged to have some other method of separating the two, differing from that already adopted. Now, in these animals, the neurocentral suture persists for a considerable period, if not throughout life; and the surfaces for the articulation of the cervical ribs, which are at first altogether below the neurocentral sutures, gradually rise, in the posterior part of the neck, until they are first cut by, and then rise above, the suture. It is very convenient, and harmonizes very well with some facts in the structure of the *Crocodilia*, to take the last of the vertebræ, in which the costal articular surface is cut by the neurocentral suture, as the last of the cervical series" (Manual of the Anatomy of Vertebrated Animals, p. 209).

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—I.—February 25th, 1874.—John Evans, Esq., F.R.S., President, in the Chair.—The following communications were read:—

1. "Geological Notes on a Journey from Algiers to the Sahara." By George Maw, Esq., F.L.S., F.G.S.

The author commences by describing the details observed on his journey from Algiers to L'Aghouat, on the borders of the Sahara. The distance traversed was 285 miles, or about 210 miles in a straight line, and in a direction nearly north and south. No eruptive rocks were observed. The oldest rock is a boss of mica-schist and gneiss behind the city of Algiers; it forms a low anticlinal, with a N. and S. strike. The pass through the gorge of the Chiffa in the Lesser Atlas shows hard slaty rocks dipping S. at a high angle; they are repeated as an anticlinal on the south side of the higher part of the Tell Plateau, and are probably Mesozoic. In the plain separating the Tell from the Hauts Plateaux, and on the south side of the latter, red and yellow sandstones form anticlinals; these rocks resemble the Bunter in mineral characters, and are overlain by red marls resembling the Keuper. In the northern escarpment of the Hauts Plateaux saliferous marls are exposed, interstratified between the sandstones and below the red and grey marls. Crystals of salt and gypsum are intimately mixed with the grey marls, and the so-called "Rochers de Sel" are capped with great blocks of rock tumbled about in confusion, the position of which the author ascribes to the failure of support due to the solution of the salt in the underlying salt-marls. A thin series of bright red and green marls is seen to overlie the Red Sandstones in several places; and above this is an immense series of dark grey marls, interstratified with argillaceo-calcareous bands, forming a great synclinal of the Hauts Plateaux, and a contorted mass on the Tell Plateau. These are probably Cretaceous. At L'Aghouat they are overlain by fossiliferous beds, probably of Miocene age. Other Tertiary beds observed are soft yellow calcareous freestones on the flanks of the promontory of Algiers and of the Lesser Atlas, and some red and grey marls and ferruginous freestone capping the Tell plateau, the former at a height of 100–900 feet, and the latter of 2500–4000 feet above the sea-level. The plain of the Mitidja, between the Lesser Atlas and Algiers, consists of grey loam with shingle-beds, of Post-Tertiary age. A similar loam covers the great plain of the northern Sahara, and rises to a height of 2700 feet. Raised beaches occur on the coast up to an elevation of 600 feet above the sea-level; and similar beaches are found inland, south of the Tell Plateau, at a height of 2000 feet.

The oldest land in the line of section is the anticlinal of mica-schist near Algiers, the strike of which is nearly at right angles to that of the other rocks. The upheaval of the Mesozoic rocks was contemporaneous with the first upheaval of the Lesser Atlas; it was followed by a long period of denudation, and this by a subsidence of at least 3000 feet in Tertiary times, during which the Miocene deposits were formed. The Tell Plateau was thus elevated at least 4000 feet, and the district north of the Lesser Atlas at least 1000 feet, the north face of those mountains probably marking a Post-Tertiary line of fault of 3000 feet. This operation was followed by a long period of denudation, and this by a Post-Tertiary depression, which the author terms the "Sahara submergence"; after which the land was re-elevated at least 3000 feet, but perhaps considerably more. A gradual subsidence appears to be still taking place.

DISCUSSION.—Mr. W. Boyd Dawkins considered an elevation of 3000 feet necessary to allow of that migration of animals through Spain and Sicily to and from Europe and Africa which took place in Pleistocene times; and this view appeared to be confirmed on physical grounds by Mr. Maw. He believed that a great axis of disturbance ran east and west along the course of the Mediterranean; and to this the strike of the beds observed by Mr. Maw was parallel.

Mr. Bauerman called attention to the excellent drawing of a desert escarpment exhibited by Mr. Maw. He said that this drawing perfectly represented what is to be seen in every dry desert country, like the north of Africa or Arabia. In the latter country the succession of the beds of Neocomian and Tertiary age was similar to that observed in Algeirs. He thought that the disturbances attributed by Mr. Maw to the dissolving out of salt, were in reality due to the dissolving of gypsum.

Mr. Davidson remarked that thirty years ago M. de Verneuil found many fossils in the region to which Mr. Maw's paper related. These included a great *Ostrea*, *Terebratulæ*, and other forms which were both Miocene and Pliocene.

Prof. Ramsay asked for information as to whether there was evidence of a great sea having extended across the north of Africa at a comparatively recent period, as he thought that this would explain certain ethnological phenomena. He was struck by the difference of the elevation of that part of the Sahara visited by the author as compared with that described by Prof. Desor.

Mr. Prestwich considered the occurrence of recent shells at so great a height something quite new. The former French observers had referred to their occurrence on the Sahara itself, and below the level of the sea. Subsidence appeared to be still going on.

The Rev. Mr. Housman remarked that the eastern coast of Spain was still rising.

The President observed that the existence of such tracts of high and absorbent soil as those described might with even a moderate amount of rainfall account for the supply of water to the Artesian wells with which the lower part of the Sahara is dotted. He mentioned that *Cardium edule* and *Buccinum gibberulum* had been found in the Sahara by Desor, and that the latter had been considered identical with a shell now found on the N.W. coast of Africa.

Mr. Maw briefly replied, and stated that the Haut Plateau referred to in his paper was a tongue of elevated land, east of which, at all events, the desert stretched away at or near the sea-level; and this was undoubtedly submerged during the period of depression. He thought that the sea also probably extended westward at the same time, perhaps to the Gulf of Guinea.

2. "On the Trimerellidæ, a Palæozoic Family of the Palliobranchs or Brachiopoda." By Thomas Davidson, Esq., F.R.S., F.G.S., etc., and Prof. William King, Sc.D.

In this memoir the authors describe in detail certain Brachiopoda, for which they propose to establish a distinct family, discuss the characters and affinities of the family, and indicate certain geological considerations which arise from their study of its members. The first known species were described in 1853 under the names of *Obolus Davidsoni* and *O. transversus*, but in 1862 Mr. Billings described an allied form as constituting a new genus called *Trimerella*. With this *Gotlandia* of Dall (1870) is identical. In 1871 Prof. Hall proposed the new genera *Rhynobolus* and *Dinobolus*, and in the same year Mr. Billings established the genus *Monomerella*. *Rhynobolus* is regarded by the authors as a synonym of *Trimerella*; and several other proposed genera being similarly cancelled, the authors retain only the genera *Trimerella*, *Dinobolus*, and *Monomerella* as constituting their family Trimerellidæ.

The Trimerellidæ are described as having a calcareous shell, generally massive, with the umbo of the pedicle valve often large, pointed, solid or hollow; area usually of considerable size, with a large solid deltidium; hinge of both valves slightly dentated; in the interior of each valve there is a more or less elevated platform, longitudinally placed, and either solid or doubly vaulted; and from the middle of its anterior end a median plate occasionally projects into the anterior half of the valve, especially in the brachial valve.

In discussing the affinities of the new family, the authors enter in considerable detail into the arrangement and functions of the muscles of the Brachiopoda, and show, from the muscular indications and other characters of the Trimerellidæ, that they are most nearly allied to the Lingulidæ, although presenting characters of sufficient importance to warrant their separation as a distinct family.

As far as is at present known, the Trimerellidæ are confined to the Cambro-Silurian and Silurian systems; but the authors indicate the probability that in the Cambrian or early Cambro-Silurian rocks a generalized form will hereafter be detected, bringing *Discina*, *Lingula*, and *Obolus* into close relationship, as regards their myology, with each other and with *Dinobolus*. Such a form would constitute the root from which the Trimerellidæ have originated.

The genera and species described are as follows:—

Genus 1. *Trimerella*, Billings (1862). Sp. 1. *T. grandis*, Bill.; 2. *T. acuminata*, Bill.; 3. *T. Lindströmi*, Dall; 4. *T. Billingsii*, Dall; 5. *T.* (?) *galtensis*, Bill., = *minor*, Dall; 6. *T. Ohioensis*, Meek; 7. *T. Dalli*, Dav. and King; 8. *T. Wisbyensis*, Dav. and King.

Genus 2. *Monomerella*, Billings (1871). Sp. 1. *M. prisca*, Bill.; 2. *M. Walmstedti*, Dav. and King; 3. *M. Lindströmi*, Dav. and King; 4. *M. orbicularis*, Bill.

Genus 3. *Dinobolus*, Hall (1871). Sp. 1. *D. Conradi*, Hall; 2. *D. Davidsoni*, Salt.; 3. *D. Canadensis*, Bill.; 4. *D. transversus*, Salt.; 5. *D. Woodwardi*, Salt.; 6. *D. magnificus*, Bill.; 7. *D. Schmidti*, sp. n.

The authors further discuss the characters of Professor Hall's *Lingulops Whitfieldi*, which they regard as in some respects intermediate between the Lingulidæ and Trimerellidæ, and describe under the name of *Chelodes Bergmani*, a fossil sent to them by Dr. Lindström under the impression that it was a Trimerellid. They indicate its points of resemblance to *Trimerella*, but think that it really belongs to the section of the Cœlenterata represented by *Calceola* and *Goniophyllum*. The fossil is from the Isle of Gothland, and was obtained from a formation equivalent to the Aymestry limestone.

Discussion.—Mr. Hicks remarked that the oldest known Lingulid is *Lingulella primæva*. The *Lingulæ* in the earliest rocks increase in size as they approach shallow deposits, and higher up, namely in the Lingula-flags, a change takes place in their form. In the Menevian beds, which were deposited in a deep sea, the shells are small. Mr. Hicks thought, therefore, that we must admit these changes to be due to changes in the conditions of existence. The *Lingulæ* had been declared to be allied to the Annelids; the Trilobites were also allied to the Annelids, and these three are the earliest known forms of life. It would be well worth while to follow the inquiry how far they were related.

Prof. Ramsay was delighted to hear the opinion expressed by Mr. Davidson, that the distinction of species was merely an abstract idea. He had always considered that the apparent distinction of species was due to the absence of the connecting links. He was thankful to Mr. Davidson for stating that in different geological formations there were forms which had received distinct specific names, but which he could not distinguish otherwise than by their derivation. Mr. Hicks had spoken of the three forms of organisms which occur deep down in the Cambrian, and founded an argument upon their rarity. But Prof. Ramsay had long maintained the heterodox opinion that the Lower Cambrian was a freshwater formation, in which marine deposits are here and there intercalated. He looked forward to the future discovery of marine Lower Cambrian beds with a much richer fauna, and considered that it was only from accidental circumstances that the fauna of the Lower Cambrian is so poor.

Mr. Etheridge also called attention to the poverty of the Lower Cambrian fauna in Great Britain.

Mr. Boyd Dawkins remarked that the most lowly organized forms seemed to be the most persistent.

3. "Note on the Occurrence of Sapphires and Rubies *in situ* with Corundum, at the Culsagee Corundum Mines, Macon Co., North Carolina." By Col. C. W. Jenks. Communicated by David Forbes, Esq., F.R.S., F.G.S.

The mine described in this paper is in a hill situated about nine miles east of Franklin, the chief town of Macon County, rising about 400 feet above the valley. The hill is a boss of serpentine protruded through the surrounding granite. The corundum occurs in five nearly parallel veins, cropping out for about a mile along the steep side of the hill in a direction N.E. and S.W. The veins all dip to the S.E. about 45°. They are thin at the surface, but widen out as they descend, the thickness of the vein in the deepest working (75 feet) being about 10 feet. They consist of a mass of chlorite, Jefferisite, and corundum, the latter forming from one-third to one-half of the mass, and occurring in crystals imbedded in the other minerals. The author gives a list of several minerals which also occur in the veins, including two new silicates, which Professor Genth has called Kerrite and Maconite. Analyses of some of these minerals and of the serpentine rock are appended to the paper. Some of the crystals of corundum weigh as much as 300 pounds. The corundum is crushed and used for grinding and polishing stones, glass, and metal; about 200 tons have been extracted from the mine. The colour of the crystals is very variable, and some of them show different colours in different parts. Many rubies and sapphires have been already procured and cut for setting.

Discussion.—Mr. Warington W. Smyth considered the communication made by Col. Jenks as a very important and interesting one. He referred to the nature of these gems, and expressed a hope that Col. Jenks's further operations might result in the discovery of large and fine crystals.

Mr. D. Forbes remarked that much credit was due to Col. Jenks for having followed up the fragmentary evidence which he originally obtained with such good results. The origin of these gems had long been a disputed point; all those hitherto obtained have been found in a waterworn state in the beds of streams. Col. Jenks had discovered the actual home of the so-called Oriental ruby and sapphire.

Prof. Tennant observed that Mr. Sheppard had years ago brought home sapphires from the same district. They were obtained from the beds of rivers.

Col. Jenks gave some further statements with regard to the depth to which the corundum-veins referred to in his paper have been worked, and stated that some of the crystals obtained from the veins could be broken across by a very slight pressure in the fingers when first taken from the vein, but that they became hard by exposure to the air.

II.—March 11th, 1874.—John Evans, Esq., F.R.S., President, in the Chair.—The following communications were read:—

1. "On the Relationship existing between the *Echinothuridæ*, Wyville Thomson, and the *Perischoechinidæ*, McCoy." By R. Etheridge, Esq., jun., F.G.S.

In this paper the author referred in the first place to the peculiar characters of the genera *Calveria* and *Phormosoma*, Wyville Thomson, and especially to those in which they approach the Cretaceous genus *Echinothuria*, S. P. Woodward, and which led Prof. Wyville Thomson to include these three forms in his group Echinothuridæ. He remarked that an overlapping of the interambulacral plates, more or less like that occurring in these three genera, is met with also in *Archæocidaris*, McCoy, and *Lepidechinus*, Hall, belonging to the group of Palæozoic Echini which McCoy proposed to call Perischoechinidæ, and which is characterized by the presence of more than three rows of plates in the interambulacral areas. As there is no overlapping of these plates in the other genera referred to this group, it includes two types of structure. The author then discussed the characters presented by the test in the genera of the Perischoechinidæ (namely *Archæocidaris*, *Palæchinus*, *Perischodomus*, *Lepidechinus*, *Eocidaris*, *Melonites*, and *Oligoporus*), and pointed out that although we have no conclusive evidence of the presence of membranous interspaces along with the overlapping plates in *Archæocidaris*, the fragmentary condition in which the remains of that form are usually found would lead us to infer their existence. No known Palæozoic genus exhibits the want of distinction between the ambulacra and interambulacra on the ventral half of the test seen in the recent genus *Phormosoma*. In *Melonites* and *Oligoporus* the author described an increase in the number of rows of plates in the ambulacra, and he indicated that all the Perischoechinidæ differ from the later Echini by the increased number of perforations in the ocular and genital plates.

Discussion.—Mr. Etheridge described *Calveria* as resembling an elastic ball rather than an ordinary Sea-urchin, its calcareous plates being held in place by a flexible membrane, and as connecting the ordinary forms with *Echinothuria*, in which the plates slide over one another like armour. He remarked that the apical disks vary in each genus; in the Palæozoic genera the ovarian plates have three or more, and the ocular plates two, perforations. The interambulacral areas in the Palæozoic genera have invariably more than two rows of plates. In *Archæocidaris* the plates have bevelled edges. The chief point of the paper was its indicating that a type supposed to have been long extinct is still represented in our seas.

Mr. Seeley observed that the buccal membrane in the recent Echinida has overlapping plates, so that if the development of the plates usually forming the remainder of the test were arrested, forms would be obtained approaching those described in the paper. He stated that in his opinion both the Echinoderm-type and the Brachiopod-type have analogies with the Annelids.

Mr. H. Woodward stated that the author of the paper had done much towards the investigation of the Carboniferous fossils of Scotland. He had detected in the Carboniferous rocks undoubted spicules of *Synapta* and *Chiridota*, showing that the soft-bodied Echinoderms were in existence at the period of their deposition. Mr. Woodward further remarked that of the Holothuridæ some forms, such as *Psolus*, have an oral disc protected by imbricated calcareous plates.

Mr. Gwyn Jeffreys added that *Calveria hystrix* was dredged off the Faroe Islands, and subsequently in the Bay of Biscay. He remarked that many missing links will probably be found hereafter, and that nomenclature will be benefited thereby; thus, if *Echinothuria* and *Calveria* really belong to the same genus, one of these names may be discarded. In support of this view he stated that the Palæozoic *Euomphalus* is identical, as regards the characters of the shell, with the recent *Homalogyra*. It is very desirable that zoologists and palæontologists should employ the same names.

2. "On the Discovery of Foraminifera, etc., in the Boulder-clays of Cheshire." By William Shone, Esq., jun. Communicated by D. Mackintosh, Esq., F.G.S.

In this paper the author described the occurrence of Foraminifera, Entomostraca, and some other small organic bodies in the Boulder-clay at Newton by Chester, and at Dawpool. They were found partly in the interior of specimens of *Turritella terebra*, and partly free in the Boulder-clay; but those obtained from the *Turritellæ* were in better condition than the others. The Foraminifera generally agree precisely with those found in the tidal parts of the river Dee. The author stated further that the *Turritellæ* containing Foraminifera are filled with a fine greyish-white sand, in which the minute fossils abound, and he discussed the probable conditions under which the deposit containing them had been formed.

Discussion.—The President remarked that there seemed to him to be two principal points for discussion in the paper; first, whether the Foraminifera cited were peculiar to brackish water; and secondly, whether the *Turritellæ* had been transported.

Mr. Gwyn Jeffreys said that the Foraminifera sent by Mr. Shone are exactly the same as those found on the shores of England, Wales, and Scotland. The *Turritella* presented a puzzling question. The Foraminifera inhabit the edge of high water, and would naturally fill any shells that might be lying on the shore about that line. They might have been transported by ground ice. The species was *Turritella terebra*, the common species on the coast. Mr. Jeffreys remarked that we know comparatively little of the Arctic fauna at present, and that it was highly desirable that an expedition should be sent to investigate the marine fauna of high northern latitudes.

Prof. T. Rupert Jones stated that the *Rotaliæ* are not identical all round the coasts, those from different localities presenting different characters, as may be plainly seen in the *Rotalia Beccarii* of the Adriatic and of the English coasts. Various circumstances seem to act in changing the forms, especially whether the animals have inhabited deep or shallow water, or water more or less fresh. The *Globigerinæ* have thicker shells in deep than in shallow water. When ill-nourished, Foraminifera alter in the style of their outline.

Prof. Hughes remarked upon the difference of opinion prevailing as to the geographical affinities of the shells found in this deposit, and as to the origin of the deposit itself. He discussed the question of the origin of the clay, and came to the conclusion that it was not a true Boulder-clay, but derived.

Mr. Seeley referred to a Boulder-clay at March in Cambridgeshire, containing Foraminifera now common on our present shores.

3. "On the Occurrence of a Tremadoc area near the Wrekin in South Shropshire, with Description of a new Fauna." By Charles Callaway, Esq., M.A., B.Sc., etc. Communicated by Dr. H. A. Nicholson.

The author stated that in an exposure of light green, micaceous shales dipping south-east at 50° at Shineton near Cressage, which are

›resented as of Caradoc age in the Geological Survey Map, he found ›eries of Trilobites and other fossils, which induced him to regard ›se Shineton shales as belonging to the Lower Tremadoc series. › described as new species: *Asaphus Eos*, *Conocoryphe Salteri*, *C. gulifrons*, *Platypeltis Croftii*, *Conophrys Salopiensis*, *Lichapyge cus-lata*, *Lingulella Nicholsoni*, *Metoptoma Sabrinæ*, and *Theca lineata*. ıe author regarded these shales as the equivalents of beds contain- g *Dictyonema* found near Malvern and at Pedwardine.

Discussion.—Mr. Etheridge differed entirely from the author, and thought the sils exhibited by him were of Caradoc age.

Mr. Hicks was inclined to refer the fossils to the Upper Llandeilo, but the frag- nts exhibited were not sufficient to enable the species to be determined.

CORRESPONDENCE.

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THE SOURCE OF VOLCANIC HEAT.

Sir,—Were it not for the sincere respect I entertain towards Mr. Mallet, I should say there is something ludicrous in the persistence th which he continues to saddle me with the advocacy of one or th of what he, writing *ex cathedrâ*, pronounces to be "the mori- nd theories of a thin crust and liquid nucleus, or of Hopkins's ry lakes." You have already, in the note to his paper, referred proofs that I have rather thrown doubts on both these hypotheses an accepted them. I have been always slow to dogmatize upon e condition of what is so glibly called the nucleus of our globe, eing how little we can know of it beyond the mere skin, and how norant we are of the laws through which extremes of temperature d pressure (not to mention other agencies, such as electric and agnetic currents, diffusion of fluids, imperfect elasticity of solids, lution of solids in fluids, and other chemical changes)[1] may fect the condition of the interior, even on the hypothesis of condensation from nebular matter. I have rather, from the st, leant to the opinion that the immediate sub-cortical matter our globe, under varying conditions of heat and pressure, not ıfrequently passes, locally, from a solid to a fluid, and even a ırtially vaporous state, *and back again*. All that I have contended r, and that rather as an undeniable fact than a theory, is that there ust exist, within and beneath the vents of active volcanos, consider- ›le masses of more or less liquid matter at an intense temperature ava), and of indeterminate extent, whether in a vertical or lateral rection. And this much, if not more, Mr. Mallet himself must ›lieve; otherwise, where is he to get the fused matter which he con- ders to have been forced upwards by hydrostatic pressure to form ıe immense masses of plutonic rocks?

The only question really at issue between Mr. Mallet and myself lates to the source of the intense internal heat so evidenced in sub- rranean lava masses; that is, whether it is derived chiefly and rectly by conduction or convection, or both, from the heated ıcleus of the globe (which Mr. Mallet himself postulates), or directly and exclusively from the crushing of the superficial rocks as they follow downwards the shrinking nucleus. The former is my view, the latter Mr. Mallet's. Let us clearly understand each other, and there need be no disagreement between us on other points.

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[1] See a paper by *Sir W. Thomson* on the Dissipation of Energy, in Nature of *›ril 9th, 1874.*

G. Poulett Scrope.

PALÆOZOIC STARFISHES.

Sir,—In the January Number of this Magazine a list is given of Palæozoic Starfishes. It is not, however, complete yet. Allow me to call your attention to a paper by Simonowitsch (Sitzungsb., Wiener. Ak. 1871, Band 64), where the following new species were described:—*Aspidosomu petaloides*, Sim.; *Asterias acuminatus*, Sim.; *Xenaster margaritatus*; *Xenaster simplex*.

This last genus is a particularly interesting one. All the above are from Devonian beds. The following have also been apparently overlooked:—*Aspidosoma Arnoldii*, Goldf.; *Cœlaster latescutatus*, Sandb.; *Asterias rhenana*, Müll.

These will considerably enlarge your list of Devonian species.

E. B. Tawney.

"CREEPS."

Sir,—Happening to read, in your March Number, Mr. R. Mallet's letter "In reply to Mr. Scrope's Observations, etc.," the "Creeps" of the Coal-fields, as described in Lyell's Elements, and in Naumann's Lehrbüch der Geognosie, at once occurred to me. Indeed, I should be very happy to learn, and be much obliged to any one who would be so kind as to inform me, whether similar causes might act upon a large scale, producing earthquakes, igneous ejections, and even elevation of mountains.

Supposing a large excavation to have been made by the eroding and dissolving action of subterranean waters (or by other means), a sink-hole or subsidence of the soil may result; but were an uplifting and fracturing of the floor with a rubbing a total impossibility, would this rubbing be sufficient to produce heat? Agreed, heat would result; let us multiply the masses twice or thrice, perhaps a greater amount of heat arises? Finally: Some part of the earth's crust having, from any reason, lost its stability or power to resist the tension, *creeps* upon a large scale taking place, fissures being produced, rubbings would result, a fragment some miles of width rising slowly, dislocations (*structure en éventail*), upheaval or subsidence of the soil or crust, and igneous ejections or even volcanic phenomena being caused; would such a state of things be at all compatible with the present state of science—or of nature?

"Mi pare però che farebbe veramente un vano sforzo d'ingegno chi volesse spiegare in questo modo le oscillazioni della crosta del globo."—Stoppani, Corso di Geologia, iii. § 473, 1873.

"Unter diesem von der Mitte aus abwärts wirkenden Druck bildete sich in dem Feldspathgebirge die fächerformige Schieferung aus."—Studer, Geol. der Schweiz, vol. i. p. 172, 1851.

"Les tremblements de terre, dont la cause est plus mystérieuse, *malgré les* travaux si remarquables et si précieux de M. Alexis

Perrey et ceux de M. R. Mallet, les soulèvements contemporains, etc."—A. D'Archiac, Géol. et Paléont., p. 737, 1866.

"This found, I will, like a veteran rat, hasten away before I have an old house about my ears."—W. Irving, Little Britain.

RÖNNE ON BORNHOLM, DENMARK,
April 12, 1874.
M. JESPERSEN.

HYBODUS, A COAL-MEASURE FISH.

SIR,—Allow me to correct an error that has inadvertently crept into my paper on the above subject, that appeared in last month's MAGAZINE. The sentence at the foot of the group of illustrations says, "Teeth of *Hybodus* (Figs. 1 and 2), compared with teeth of *Cladodus* (Figs. 3–6)." It should have been, "Teeth of *Hybodus* (Figs. 1–3), compared with teeth of *Cladodus* (Figs. 4–7)." The whole tenour of my paper was to prove Fig. 3 a tooth of *Hybodus*, and not of *Cladodus*.

NEWCASTLE-ON-TYNE.
W. J. BARKAS, M.R.C.S.E., etc.

THE FLEET. IN REPLY TO THE REV. O. FISHER.

SIR,—The Rev. O. Fisher has written a short letter, in which he objects to certain statements in my paper on the origin of the Fleet. I did not attempt to disprove Mr. Fisher's theory, as I considered it unnecessary if I gave a better. I don't think I said the present shore-line of the Fleet was formed by marine erosion, because since it became a lagoon it must have been considerably modified; due to the meteoric waste of the adjoining land, the growth of peaty accumulations, and the erosion due to wind and the waters of the lagoon. I should imagine the original shore-line was a gradual curve, while at present it is full of indentations and small bays.

From what data can Mr. Fisher affirm that there were "never marginal cliffs to the lagoon"? If cliffs had once existed, and composed of frail materials, they would long since have disappeared, and all surface traces of them have been obliterated, the ground being now a long gradual slope; this is the case with the lagoon called Lady's Island Lake, mentioned in my paper. But in drainage or similar works, sections will be exposed showing the site of the cliffs. From the Ordnance Maps I question if any of the margins of the lagoons I enumerated would be considered due to marine erosion; yet in most cases in their vicinity the old sea cliffs can be traced, but not always without railway works or other deep cuttings.

I strongly suspect if the bank of the Fleet is moving inwards, that the margin of the Fleet will do likewise, and this seems to be allowed by Mr. Fisher, so that if its area is curtailed on one side, it increases on the other, and eventually, if the bank is moved backwards to the original cliff-line, still the Fleet will be found behind it, or an alluvial flat that can be reclaimed.

I do not understand what Mr. Fisher means when he says, in connexion with the bays he enumerates, they "cannot possibly have been formed by the sea, they must be drowned valleys." Now all the lagoons I have seen *must be* "drowned" or submerged valleys;

but that does not prevent marine action having previously taken a part in excavating them. Marine and meteoric denudations may have formed them at the first, but marine action built the bar across them, while marine and meteoric action is now filling them up, sometimes one and sometimes the other being the chief worker.

G. H. Kinahan.

MISCELLANEOUS.

Discovery of a Coal Seam at Sandwell Park.—A coal seam, two and a half feet thick, was lately struck in the Sandwell Park trial sinking, West Bromwich, at a depth of 380 yards, the seam "dipping" six inches per yard. Several mining engineers of great experience have visited the colliery, and pronounce the seam to be "brooch coal," in which case there can be little doubt that the thick coal measure is not far distant. The discovery has caused a good deal of excitement in the district, and an important advance in the value of the shares has already been established. Subsequently another seam known as the "Herring-coal" was reached, and the last reports state that they are still sinking in splendid Coal-ground.

OBITUARY.

PROFESSOR PHILLIPS,

Born 25th Dec. 1800. Died 24th April, 1874.

The sad intelligence has just reached us of the loss of one of England's most eminent geologists, and, to very many amongst us, of a most dear and valued friend. Prof. Phillips's death was the result of an accident. On the 23rd April he had been dining at All Souls' College, and was returning, accompanied by the Principal of Jesus, when, in crossing the top of a staircase, his foot unhappily slipped, and he fell headlong down a flight of stone stairs. Paralysis and unconsciousness came on instantly, and about one o'clock on the 24th he expired. He was just 73 years of age.

Left an orphan at eight years of age to the care of his uncle William Smith, well known as "the father of English Geology," he was, as one may say, "to the *hammer* born." His connexion with the Yorkshire Philosophical Society dates back to 1826, and with the British Association from its establishment in 1831; indeed "he was the life and soul of its annual *réunions*." He presided over his favourite Geological Section last year at Bradford in his usual happy and delightful manner.

His connexion with Oxford dates back to 1853. He has long outlived Buckland, De la Beche, Faraday, and Murchison, and has survived Sedgwick little more than a year. Few men have been more highly esteemed in life or will be more sincerely regretted in death than John Phillips.[1]

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[1] *See Biographical* Notice of Prof. Phillips (with a Portrait), Geol. Mag. 1870, *Vol. VII. p. 301.*

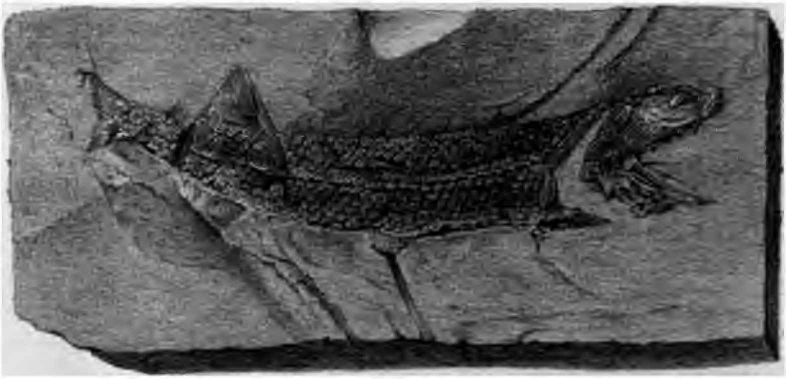


Fig. 1.

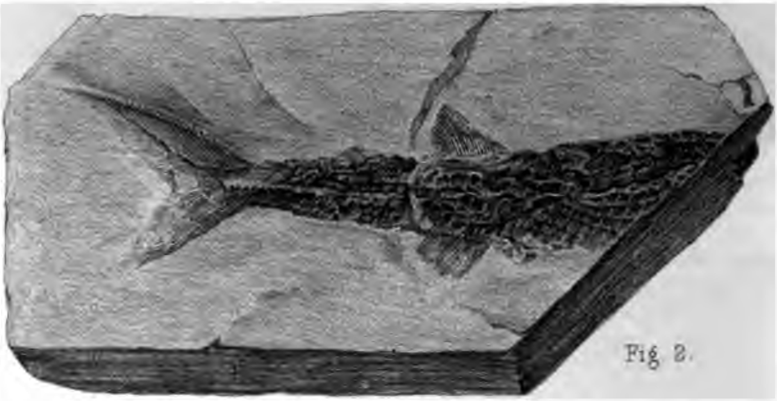


Fig. 2.

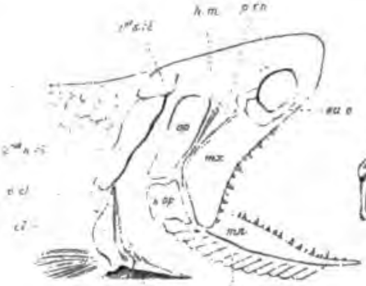


Fig. 3.

Fig. 4.

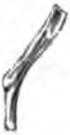
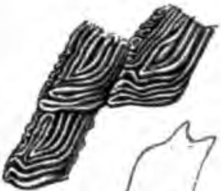


Fig. 5.



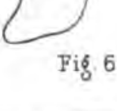


Fig. 6

Mc Farlane & Erskine, Lithrs Edinr

Cycloptychius carbonarius, Huxley, Coal Measures,
NORTH STAFFORDSHIRE

THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE II. VOL. I.

No. VI.—JUNE, 1874.

ORIGINAL ARTICLES.

I.—Description of *Cycloptychius carbonarius*, Huxley, from the Coal Measures of North Staffordshire.

By R. H. Traquair, M.D.

(PLATE XII.)

THE beautiful little fish, from the North Staffordshire "Deep Mine Ironstone," named by Prof. Huxley *Cycloptychius carbonarius*, has hitherto never been figured, and only a brief description of it was published in 1865 by Prof. Young, of Glasgow.[1] Cursory allusion has been made to its teeth by Messrs. Hancock and Atthey,[2] and to its scales by Mr. T. P. Barkas.[3]

Mr. Ward, of Longton, Staffordshire, having kindly lent me the beautiful series of specimens in his collection, I am enabled to give a more detailed description, which I hope will be rendered intelligible by the figures on the accompanying Plate XII.

General Proportions.—All the specimens but one are the remains of small fishes, measuring from about 3½ to 4½ inches in length; the exception is formed by the head and fore-part of the body of an individual, which must have, when entire, measured at least 6 or 7 inches. The general form is elegant and slender; the greatest depth is at the shoulders, whence the body gradually tapers towards the caudal extremity. The pectoral and ventral fins are small; the dorsal, moderate in size, is placed so far back as to be exactly opposite the anal, which is nearly its counterpart in form and dimensions; the tail is perfectly heterocercal, but not very inequilobate.

Among the specimens, in which the general shape of the entire body is well shown, considerable differences occur in the general proportions; some being shorter and deeper, others more elongated and narrow. These differences are illustrated in the following table of measurements of four selected specimens; the *entire lengths* from head to tail must, however, be taken as only approximate, as the only absolutely perfect *tail* in the suite of specimens (Pl. XII. Fig. 2) unfortunately wants the head and fore-part of the body.

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[1] British Assoc. Reports, 1865, vol. xxxv. p. 318.

[2] Annals and Mag. Nat. Hist., 1868, 4th series, vol. i. p. 362.

[3] Illustrated Guide to the Fish, Amphibian, Reptilian, and supposed Mammalian Remains of the Northumberland Carboniferous Strata, London, 1873, p. 36; Atlas, fig. 140.

	No. 1.		No. 2.		No. 3.		No. 4.	
	inches.	lines.	inches.	lines.	inches.	lines.	inches.	lines.
Entire length (approximate)	4	1			3	10	3	3
Length of head		10		10		10		8
From tip of snout to opposite origin of ventral fin	1	9	1	9	1	3	1	3
From tip of snout to opposite origin of dorsal fin...........	2	6	2	4	2	0	2	0
From tip of snout to opposite origin of caudal fin.......................	3	5	3	0	2	10	2	11
Depth at shoulders......................		8		7		10		7

Nos. 3 and 4 are proportionately shorter and deeper; and, while Nos. 1 and 2 agree in their measurements as far as the dorsal fin, the distance between that and the caudal is less in No. 2 than in No. 1. Again, in a fifth specimen, that represented in Pl. XII. Fig. 2, the distance between the dorsal and anal fins and the caudal is proportionately greater than in either of the two last mentioned, as is also the case in yet another example of the slender variety. Nevertheless, I cannot think that any specific distinctions are indicated by these differences in the measurements; the specimens agree too well in other essential points. We must, in fact, besides individual variability, take into account changes occurring after death, and in the course of entombment and mineralization, by which more or less distortion and change of the original form and proportions must have been produced. The bodies of the shorter forms, No. 3 and No. 4, show a peculiar corrugated and almost crumpled aspect, seen also in the part between the anal and caudal fins in No. 1 and No. 2, in which that region is shorter than in the two still more elongated forms alluded to. The normal shape of the fish, when alive, would, I think, on the whole correspond with that of the more slender examples, the head occupying about $\frac{1}{5}$th of the total length, while the ventrals would be situated at rather less than $\frac{2}{5}$ths, and the beginning of the dorsal and anal fins at less than $\frac{3}{5}$ths from the tip of the snout.

Head.—The osteology of the head, so far as can be made out, closely corresponds in general plan with that in *Palæoniscus.* In none of the specimens can a clear view be obtained of the individual form and boundaries of the bones of the cranial roof; their external surfaces seem however to have been finely tuberculated, the tubercles sometimes being confluent into short ridges. There is distinct evidence of extensive ossification of the base and side walls of the cranium, but here again it is impossible to make out the individual bones. The ethmoidal region is prominent, and forms a bluntly-pointed projecting muzzle. The bones of the face are more distinct, and many of them quite determinable. The *hyomandibular* (Fig. 4, and Fig. 3 *hm.*), partly seen in front of the operculum in most of the heads, and quite isolated in one specimen, is a somewhat long-shaped bone, which descends obliquely downwards and backwards towards the articulation of the lower jaw, thus carrying the gape very far

It is compressed laterally, and below the middle it is slightly
·wards again at a low angle; *in situ* the upper part is very
the lower nearly perpendicular. There is no trace of a
:tic, and, as in the recent *Polypterus*, it was probably absent.
'*atoquadrate* apparatus also in form reminds us of that in
·us, and forms a bony lamina extending from the front of the
art of the hyomandibular to the ethmoidal region; its indi-
)ssifications cannot unfortunately be distinguished. The
placed far forwards, and surrounded by a chain of ossicles,
xact number can scarcely be determined; as in *Palæoniscus*,
a very prominent one seen forming the inferior and the
part of the posterior orbital margin. The *superior maxillary*
ig. 3 *mx.*) is stout and broad, till it comes to the orbit, where
ɜr margin is suddenly cut out, in a semilunar manner, to
:e with the suborbital chain, the anterior extremity passing
s below the orbit in a fine point towards the premaxillary,
eems to be well developed, though its exact configuration is
ι. Above the superior margin of the maxillary may be seen
narrow plate, pointed behind, and covering what remains of
ɜk in front of the operculum and hyomandibular. This is
ɪperculum (*p. op.*); the corresponding plate in *Palæoniscus* is
ned as such by Quenstedt,[1] and, comparatively small as its
ons are, it certainly occupies a relative position similar to
the great preopercular cheek-plate of *Polypterus*. The *oper-*
ɔp.) is rather narrow, though broader above than below; its
r inferior angle is acute. Below it is seen a small nearly
e *suboperculum* (*s. op.*). I am equally unable with Dr.
to find any trace of *interoperculum*. The lower jaw (*mn.*),
eparate elements it is impossible to define, is stout in its pos-
ɪlf, but tapers to a point anteriorly; the symphysial extremity
:ly turned up. Its external surface is marked with beautiful
:lges and tubercles. The *branchiostegal rays* (*br.*) are many
ımelled, forming a series of little oblong plates, extending
e suboperculum on each side between the rami of the lower

.—The teeth, with which the margins of both jaws are
ıre small, smooth, conical, and sharp-pointed, with apex slight-
ɔd inwards. They are of two sizes, "large" and "small"; in
y specimens the large ones measure about $\frac{1}{24}$th inch in length,
ı others, very minute, are clearly seen in one specimen to
a more external position on the edge of the jaw. I have not
opportunity of examining their microscopic structure; but,
ıg to Messrs. Hancock and Atthey,[2] their apices present the
culiar "enamel-cap" seen in the teeth of the allied forms
'*scus*, *Pygopterus*, etc., and also in those of the recent *Lepido-*
d *Polypterus*.

der girdle.—The elements of the shoulder girdle are very
y seen. The 1*st supra-clavicular* (*supra-scapular* Owen,

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[1] buch der *Petrefactenkunde, Tab.* 18, *fig.* 3.

[2] *'. p. 362.*

post-temporal Parker), is a short, nearly triangular plate (Fig. 3, 1st *s. cl.*), seen immediately behind the cranial shield; below it is seen the more elongated *2nd supra-clavicular* (*scapular* Owen, *supra-clavicular* Parker): this bony plate (Fig. 3, 2nd *s. cl.*) is broader above than below, and obliquely pierced by the lateral slime-canal. The next bone (*cl.*) is the *clavicle* (*coracoid* Owen), consisting of two portions, upper and lower. The upper portion is much the larger, and articulates above with the *2nd supra-clavicular*; the lower, short and square, is set to the other at an obtuse angle, so as to project inwards towards the ventral middle line; between the two portions behind is a pretty deep notch, where the pectoral fin projects. In front of the lower end of the clavicle, and closely articulated with it, is yet another bony plate (*i. cl.*), long and pointed, bent longitudinally upon itself, and passing forwards and inwards to meet its fellow of the opposite side. This is the *inter-clavicular* of Parker, and clearly corresponds to the bony plate placed below the lower end of the clavicle in *Polypterus*, and also in *Accipenser*. There is also some trace of a small *post-clavicular* (*p. cl.*) immediately behind the junction of the clavicle and the *2nd supra-clavicular*.

Scales.—Dr. Young, in the paper alluded to, refers to the scales as being "cycloidal," but remarks further that "the obliquity of their axis, from the production of their posterior inferior angle, gives them *in situ* a rhomboidal appearance."[1] Mr. Barkas also states the scales to be "cycloidal," and that they "more closely resemble those of *Cœlacanthus* than do the scales of any other Coal-measure fishes."[2] The well-preserved specimens before me, however, show that the scales, instead of being cycloidal, are in reality rhomboidal, and that in form and arrangement they conform in every essential respect to the type of scales seen in *Palæoniscus* and its allies. The principal peculiarities are, their thinness, the rounding of their posterior inferior angles, and their upper margin being perhaps rather more than usually overlapped. They are as usual arranged in oblique rows; the longitudinal series are, however, not always regular. The form of the scales of the flank, as seen in a specimen in which they are much disjointed (see Fig. 6), is rhomboidal, with the anterior superior angle acute and pointed, the posterior inferior angle rounded; from the middle of the superior margin a pointed peg projects upwards for articulation with the under-surface of the scale above. The ornament of the free surface consists of fine, raised, thread-like ridges, running in the main parallel with the anterior, inferior, and posterior margins, and of which arrangement the drawing Fig. 5 will give a better idea than any further description. One ridge running along the upper part of the posterior margin is generally more or less zigzagged, so as to give almost a crenulated aspect to that margin.[3] The scales of the flank do not alter much in size or shape till we come to the tail, when they become very small, and acutely lozenge-shaped on the prolongation of the body along the upper caudal lobe. The scales of the back and belly are smaller than those of the sides; azygos, somewhat heart-shaped scales are often seen in the mesial dorsal line, where the oblique rows of each side meet; but I do not see any specially large ones in front of the dorsal and anal fins, as in *Palæoniscus.* The upper aspect of the caudal body prolongation is, however, bordered, as in all the members of this family, by a series of V-shaped scales; whether or not these become a double series by the complete splitting of the legs of the V, is not seen. The *lateral line*, marking the course of the lateral slime-canal, is very distinctly traceable from the *2nd supra-clavicular* along the middle of the side of the body to the origin of the lower lobe of the caudal fin; the scales which it traverses being each marked with a slight ridge or elevation, which disturbs very considerably the regularity of the proper striæ of the scale.

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[1] *Op. cit.* p. 319.

[2] *Op. cit.* p. 37.

[3] The ornament of the surface is in most of the specimens very badly preserved, or rather, badly seen, from the tendency of the superficial layer of the scale to split off. *It is unusually* well exhibited in the specimen, Pl. XII. Fig. 1, from whose scales the *above description*, and the magnified view in Fig. 5, were taken.

Fins.—The pectorals and ventrals are very small, and have apparently rounded terminations; the ventrals, each having about 20 delicate rays, are placed nearly midway between the pectorals and the anal. The dorsal is placed very far back, being quite opposite the anal, which it resembles both in size and shape; both are triangular and pointed, with the posterior margin rather concave. To count the fin-rays in such delicate little fossil fishes is rather a difficult and uncertain matter; but I would estimate the number in the dorsal and anal fins at about 30 for each, of which the posterior 10 are very fine. They do not bifurcate till near their terminations; their transverse articulations are rather distant, especially near the attachment of the fin; minute fulcral scales, rather thinly set, may be seen along the anterior margins. The caudal is deeply bifurcated; both lobes are pointed; the upper one is bordered above by the scaled body-prolongation, and projects rather further back than the lower. The fulcral scales along the margin of the lower lobe are more distinct and closely set than those of the dorsal and anal fins. About 18 or 19 rays go to form the lower lobe; the rest become exceedingly fine and delicate as we proceed on towards the tip of the upper lobe.

Internal skeleton.—In none of the specimens I have examined is there any trace of internal skeleton in the trunk. The fish was evidently notochordal.

Conclusion.—The entire structure and aspect of *Cycloptychius carbonarius* prove it to be a member of the same extinct family of Lepidosteoid Ganoids to which *Palæoniscus*, *Pygopterus*, *Oxygnathus*, etc., belong. Dr. Young has already correctly recognized its affinity to *Palæoniscus;* but I cannot agree with him in assigning to it any special relationship to the *Catopterus* of J. H. Redfield, as the latter genus is imperfectly heterocercal, and therefore can hardly be included in the family of Palæoniscidæ, any more than the genus *Ischypterus* of Egerton.[1]

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[1] See the description and figure of *Catopterus*, by W. H. Redfield, Ann. Lyceum Nat. Hist. New York, iv. p. 38, pl. i.; *and by* J. C. Redfield, Am. Journ. Sc. 1841, xli. p. 27.

EXPLANATION OF PLATE XII.

FIG. 1. *Cycloptychius carbonarius*, Huxley; caudal region imperfect. Nat. size.

2. Another specimen, shewing the hinder part of the body with perfect tail. Natural size.

3. Sketch of the side of the head with the bones of the face and shoulder. Somewhat enlarged and restored.

   op. operculum; *p. op.* preoperculum; *s. op.* suboperculum; *s. o.* suborbital; *mx.* maxillary; *mn.* lower jaw; *hm.* hyomandibular; *br.* branchiostegal rays. *1st s. cl.* first supra-clavicular; *2nd s. cl.* second supra-clavicular; *cl.* clavicle; *p. cl.* post-clavicular; *i. cl.* interclavicular.

4. Hyomandibular bone, enlarged.

5. Magnified view of the ornament of the scales of the flank, from the specimen represented in Fig. 1.

6. Outline of an isolated scale, magnified, from a specimen in which the scales were disjointed.

II.—ON THE PHYSICAL CHANGES PRECEDING THE DEPOSITION OF THE CRETACEOUS STRATA IN THE SOUTH-WEST OF ENGLAND.[1]

By C. E. DE RANCE, F.G.S., of the Geological Survey of England and Wales.

Zone of Scaphites æqualis.—Beneath the Yellow Chalk of West Dorset and South Somerset occurs a very constant bed of yellow calcareous paste, with glauconitic grains, and containing at the base numerous small minute pebbles of quartz, the whole being so well cemented together as to be used at Pennys Toller, near Beaminster, as a rough building stone. In 1865 I collected from this zone a large number of fossils, most of which I found to occur in the Cambridgeshire "Chloritic marl," Chardstock, Buckram, and Pennys Toller being perhaps the most fossiliferous localities. At the base occurs a well-marked horizon of *Ammonites Rhothomagensis.*

Zone of Pecten asper.—A bed of dark brown-coloured quartzose sandstone, 20 feet thick, sometimes forms the top of the Upper Greensand. It is well seen at Seamark Hill, where it contains *Exogyra conica*, and at Tytherleigh. Eastwards, from Seamark to Buckram, it thins out, and overlies and is partly equivalent to a bed of light-green coarse-grained sandstone, about 16 feet in thickness, in which the *Pectens* occur. This portion of the bed is very constant, being seen in most of the sections on the top of the Oolitic hills from Chard in Somerset to Eggardon Hill in Dorset—a range of country more than twenty-five miles in length.

Zone of Exogyra conica.—These beds consist of very soft bright yellow (occasionally pale green-coloured) sand, with vast numbers of *Exogyræ*, often of very large size. Both the two last-mentioned zones are present at Blackdown. It is generally about 15 feet thick, and is usually present in all the Lower Cretaceous sections of East Devon, South-west Somerset, and West Dorset.

Fox Mould.—The deposit locally known by this name consists of loamy sand. At Pinhay it reaches a thickness of 60 feet, and is nearly as thick at Black Ven, where it overlies the Cow Stones. In the latter locality it forms a loose shifting mass, through which the cutting of the Lyme Regis road has been carried, and has been the

[1] *The publication* of this paper has been unavoidably postponed.—ED. GEOL. MAG.

scene of numerous landslips. A species of *Belemnite* occurs in it, and one of *Pecten* at Wambrook Valley.

Cow Stones.—These siliceous concretions occur immediately at the base of the Fox Mould at Alston, Chardstock, and Black Ven; they are often six feet in length, and constitute the zone of *Hoploparia longimana.* Of the former, 60 per cent. of the species are common to the Whetstones and other Blackdown-beds, and about 32 per cent. occur in the Folkestone Gault.

Gault.—This deposit occurs at Golden Cap, Stonebarrow; Black Ven, and Pinhay Cliff. It consists of dark grey-coloured stiff clay, difficult to distinguish from some beds of the Lias, on which it rests. At Black Ven, where it is perhaps best seen, it is divided from the Cow Stones above by a few feet of yellow sand. A comparison of the fossils found in this clay in the Museum of Practical Geology, and in the collection of Mr. Day, now amalgamated with the former, and in my own collection, with those of the Folkestone Gault, tends to correlate the Dorsetshire Gault rather with the *Lower* Gault of Folkestone than the Upper, in which case, supposing the Whetstones in the Blackdown-beds to represent the Cow Stones, they and other portions of the former may be the equivalents in time of the Upper Gault.

The Fox Mould, Cow Stones, and Gault are absent in the inland Dorsetshire sections, at Lewston and Seamark Hills, and Buckram, and the "*Exogyra conica* sand" rests upon a dark olive-green coloured sand, without fossils and full of water. The sand is particularly well seen at Hooke Park, a few miles east of Beaminster, which sand is probably the equivalent in time of the Fox Mould of Lyme Regis, which is not present in the White Cliff section at Beer, where Sir Henry de la Beche considered the Fox Mould to be represented by greenish-yellow and brown sands, containing chert nodules, resting on green sands with concretions of sandstones, the equivalents of the Cow Stones of Lyme.

In the Beer section the *Exogyra* and *Pecten asper* zones are represented by numerous bands of yellowish-brown sandstone, with green earth, and chert seams, and nodules. The base of the Chalk line is extremely compact and siliceous, and is the equivalent of the Chalk with quartz grains of Pennys Toller and Lyme, and the "Beer stone" of the quarries of Beer.

Before leaving the description of the Cretaceous beds of this area, it may be well to mention the vast sheets of more or less angular gravels occurring on the tops of all the Cretaceous hills. In the upper portion the flints are slightly rolled, and mixed with numerous rolled quartz pebbles. In the lower portion the ground often consists of masses of fractured chert, resting on a yellow clay, occurring more or less in pot-holes, with long gnarled black-coated flints. The whole series is well seen at Wambrook Valley, Alston, Tytherleigh, Lewston, Seamark Hill, White-sheet Hill, Cotleigh Hill, Pennys Toller, Hooke Park, and Golden Cap.

Between Eggardon and Dorchester the country is composed of a large sheet of Chalk, through which the Upper Greensand appears at

East Compton and Winterborne Abbas, being partly brought up by faults. The escarpment of the Chalk, with the Upper Greensand at its base, runs almost continuously from Eggardon, by Askerswell, Long Bredy, Little Bredy, to Abbotsbury Common, where it terminates against a large fault running East, which brings up the Oolites, as shown on the Geological Survey Map, Sheet 17. The fault, however, runs along the higher part of the Chalk escarpment for its greater portion, and the top of Greensands appears from Bincombe to Poxwell. Southward and westward of this fault the Oolites strike nearly East and West, and the beds are often repeated by "strike faults" running in the same direction, which are evidently of Post-Cretaceous age. In the tract between Abbotsbury and Weymouth Bay the repetition of the beds is due to several W.N.W. anticlinal and synclinal rolls, the tops of which appear to have been worn into one uniform plain of marine denudation, sloping from the W.N.W., on the surface of which the Upper Greensand was deposited. Westward from Burton Bradstock the Oolites and Lias dip steadily to the south-east, bringing up higher and higher beds, on the eroded edges of which rests the Upper Greensand, which further inland is surmounted by the Chalk. In addition to the East and West faults traversing the Oolites, there are a great number of faults running about N. 30 E., which cut off and are evidently of later date than the former system.

The subsidence in the strata before the deposition of the Cretaceous, pointed out by the anticlinal and synclinal rolls in the Oolitic strata, if commencing at an era when the whole of the west of England stood well *above* the sea-level, would offer exactly the conditions as the curved surface of the ground sunk beneath the waves to produce a plain of marine denudation, which Professor Ramsay has demonstrated must be the invariable result "when a country is gradually sinking, and the rate of waste by the waves on the shore (as it were slowly entering into the country) be proportionate to the rate of sinking."[1]

The direction and inclination of such plains of ancient date will have been more or less modified, by curvature caused by subsequent subsidences, and by faults the result of more recent elevations. And even now modern plains may have been locally modified in direction by the strata attacked by the waves not having been always deposited horizontally, but inclined at small angles around islands of older rock left by still older denudations, or brought up by faults and flexions. Thus in the south of England Mr. Prestwich, F.R.S., in his address to the Geological Society on resigning the President's chair, describes the great ridge of Palæozoic rocks which is believed to pass beneath the Secondary rocks from the Rhine to South Wales, connecting the old rocks of the Ardennes with those of the Mendips, bringing up Coal-measures in detached basins on its northern flanks, and probably also on the south, as is believed by Mr. Godwin-Austen, who worked out the question in 1856.

From these facts it is clear that in advancing from Lulworth to

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[1] *Physical Geology* and Geography of Great Britain. Fourth Edition.

Lyme Regis the Lower Cretaceous rocks overlap lower and lower Oolitic beds, in consequence of the latter rocks having obtained their anticlinal and synclinal curves, the upward rolls of which were worn into a plain of marine denudation sloping E.S.E. before the deposition of the Upper Greensand, while both systems of faults traversing the district are of later age than the Chalk.

It would appear that the movement which resulted in the axes and easterly dip was one of subsidence, probably commencing after the Portland Oolite had become a land-surface, through the combined action of deposition filling up the shallow sea-bottom, and by an elevation sufficient to place a considerable portion of the Oolitic sea-bottom above the waves, which area comprised probably, not only that covered by the Purbecks, but a considerable tract to the west. And that this subsidence, though sufficient to produce the various axes and flexures, to submerge the area sufficiently for marine forms to exist in Purbeck times, was not of very long duration, or of very great extent, as the freshwater Wealden beds were immediately deposited over the Purbecks.

This axis of old rocks produced a great east and west disturbance, causing numerous sharp narrow anticlinals and synclinals, both in Westphalia, Belgium, France, Somerset, and Pembroke, in which curves lie very long and narrow troughs of Coal-measures, extending for many miles. Mr. Prestwich lays stress on the great thinning out in a southerly direction of the "pre-Cretaceous Secondary rocks" observed by Mr. Hull, the Great and Inferior Oolites having thinned from 792 feet in Gloucestershire to 205 feet in Oxfordshire, and the Lias and Trias from 1090 to 400 (?), and the Trias of Lancashire from 5600 to 600 feet in Warwickshire; and he shows that this general southerly thinning out points to old pre-Triassic land, which may well have been the old ridge of Palæozoic rocks running out from the Mendips. There is, therefore, little doubt that the Palæozoic rocks are overlaid unconformably by successive Triassic, Liassic, and Oolitic beds, precisely as the latter are overlapped by various Cretaceous rocks.

The great east and west axis of disturbance is believed to be of post-Carboniferous and pre-Permian age, or of which is precisely the era to which Prof. Hull writes, "The northern limits of the Lancashire and Yorkshire Coal-fields were determined by the upheaval and denudation of the beds along east and west lines, while the Coal-fields themselves remained in their original continuity across the region now formed by the Pennine hills from Skipton southwards." [1]

In the paper from which the above observation is quoted, Prof. Hull shows that the Lancashire Coal-field is traversed by three systems of fault; of which my own observations in the survey of 600 square miles of West Lancashire have given me many opportunities of corroborating. Of these the latest has a direction nearly N.N.W., and is probably of post-Jurassic age; they cut off the post-Carboniferous E.N.E. faults equally with the post-Permian N. and S. faults.

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[1] Prof. Hull, Relative Ages of Leading Physical Features and Lines of Elevation of the Carboniferous District of Lancashire and Yorkshire, Quart. Journ. Geol. Soc. 1868, p. 331.

Sir H. de la Beche regarded the depression that occurred after the deposition of the Wealden beds as of probably small extent, and believed the beds overlying them denoted "comparatively quiet accumulation of sedimentary matter . . . subsequently to the change, as previously," and he remarks on the absence of "coarse detrital beds resting upon the upturned Wealden deposits." And he states that "we are led to suppose that the change may, geologically speaking, have been gradual; and that subsequently to the gradual rise of a portion of Western Europe, which brought a part at least of the Oolitic series above the sea, a gradual depression took place, which permitted the Chalk and Greensand to overspread a wide area, covering up a variety of older rocks. Under this view we should expect the beds forming the lowest portion of the Greensand to be best developed when the depression beneath the sea was first effected, and that consequently the higher beds would be most continuous over the area subsequently occupied by the whole Cretaceous series, due allowances being made (more particularly as to the sands and clays) for variations caused by the operation of modifying conditions in horizontal distances. . . . . And we might expect . . . . that while the lowest beds of the Greensand were accumulating in the East of England, dry land still existed in the West."[1]

This depression would appear to have begun in the Yorkshire and Lincolnshire area, where the lower Neocomian beds are so extensively developed, and probably also under Norfolk, where the bare Chalk occurs (Norwich well) at a depth *lower* than the old rocks of Harwich. The line of greatest depression probably extended along an axis ranging from the Humber across the German Ocean to Hanover; and the subsidence appears to have been more extensive on the Southern than on the South-west margin of the basin.

The continental epoch, with large inland seas and lakes, which Prof. Ramsay has shown commenced with the Old Red Sandstone era, appears not only to have lasted up to the close occupied by the deposition of Triassic times, but to have continued, though with more limited area, during the Liassic and Oolitic periods, when it again gained in area, and was drained by a large continental river, in the delta of which were formed the Purbeck and Wealden beds. A movement of subsidence set in to the East, which gradually extended to the West, introducing marine conditions, the strata of the entire Cretaceous system exhibiting a gradually deepening sea-bottom.

Did the continental land wholly disappear beneath the waves at the close of the Wealden era? The researches of Mr. Judd have shown that the Wealden of Germany was deposited by a distinct river from that which formed the deposits of that age in England and France, and that the highest or newest portion is present in France, being often merely a subordinate to marine beds of Neocomian age; and he points out with great force the truth of Prof. Huxley's proposition, that the time will come when two distinct but parallel classifications for dissimilar strata will have to be made, from the breaks in the terrestrial and fluviatile fauna not corresponding to those in the marine. Thus in the beds of Punfield Cove, Swanage Bay, lying immediately above the Wealden, occurs a fluvio-marine fauna, the marine contents of which Mr. Judd has shown are Neocomian, while its fluviatile affinities are with the Wealden. And, again, with the fluvio-marine beds of the Purbecks beneath, the marine affinities are with the Oolites below, while the freshwater and terrestrial are Wealden, as shown by Prof. Forbes, who in 1850 recognized the Neocomian facies of the fine collection of marine fossils made by Mr. Godwin-Austen, F.R.S., at Punfield, and presented to the Geological Society. This "Punfield formation" shows the strongest palæontological affinity to the middle portion of the middle Neocomian Coal-field of Utrillas,[1] and other places in Eastern Spain, where three Coal-basins occur, which it is believed will supply "the whole of the peninsula for more than 200 years."

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[1] *Report on* the Geology of Cornwall, Devon, and West Somerset, 1839.

The researches of M. Lory have shown that the *Rhodanien* of M. Renevier is as closely related to the Upper Neocomian (*Aptien* of D'Orbigny) as it is to the Middle Neocomian (*Urgonien* of D'Orbigny, white limestone with *Rudistes*). This proves, as pointed out by Mr. Judd, the arbitrary division of the Upper and Middle Neocomian. And when we see a marine fauna of upper Middle Neocomian age almost intercalated in the upper part of the Wealden, and the equivalents of a formation occurring in Spain more than 500 feet in thickness associated with large and numerous coal and lignite beds, it is difficult to resist his conclusion, that "as no break has ever been shown to exist in the succession of Wealden beds in the south of England, we are compelled to conclude that they represent the whole of the vast interval between the Upper Oolite and the Upper Neocomian. Between the Purbecks and the Portland Oolite the change is equally gradual, for Mr. Godwin-Austen shows that the Swindon Purbecks absolutely alternate with beds containing a Portland fauna. Just as in more recent times, sections occur at the edge of the great belt of blown sand surrounding the Lancashire coast. The sand resting on the great peat plain contains seams of peat with freshwater shells, alternating with bands of sand, which become thicker and thicker in the upper parts of the sections, the sand having gradually silted up the peat morass, and the freshwater shells being replaced by rolled and windworn sea-shells.

Everywhere, indeed, in the geological formations, a change of sediment appears to have brought a change of fauna, and in most cases a recurrence of physical conditions induced a return of the old fauna. In these cases it is clear that the change of sediment, and of other physical conditions, depth of sea, climate of air, and temperature of water, must have been local, though possibly extending over large areas, and that extinction of species could only have taken place when the area of change was coincident to or greater than the area of habitat of that species. The longer time elapsing during the period of change, the greater chance would hardy species have of becoming naturalized, and living in conditions as to quality of sea bottom and depth differing from those they had been accustomed to, and for migrating to more favourable areas.

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[1] The total thickness of the lignite and coal series, consisting of the Upper and Middle Neocomian *lying beneath the* Gault, is given by Mr. Judd at 1600 feet.

A comparison of many of the species occurring in the Phosphatic seams of the Lower Greensand (Upper Neocomian of Kent) with those from the junction bed "*Am. interruptus* Zone" of the Gault of Folkestone, the "nodule bed" dividing the Lower and Upper Gault of the same place, and with those of the zone of *Scaphites æqualis* (Chloritic Marl) of Dorsetshire and Cambridge, shows a striking number of species in common, and much resemblance in physical aspect,—rolled and water-worn shells, drifted wood bored by shells, rolled bones of Saurians, drifted pebbles, and masses of phosphatic matter, which can sometimes be made out to be molluskite, probably of large *Rostellariæ*.

The facies of the whole suggests a beach and shore deposit, which is to a certain extent borne out by the habitats of the recent analogues of the species of shells of molluscs found associated. The recurrence of these species at the precise era of time when physical conditions were changing would appear to indicate the continuance of an old coast-line, from which the shells were washed by currents, which coast-line would appear to have continued throughout the whole period occupied by the whole of the Lower Cretaceous system of the south of England. The reason why currents should have flowed from this old land at the moment when physical changes introduced changes of sediments is difficult to explain. Possibly the presence of the molluskite may be due to large quantities of freshwater coming down to this old coast-line, and killing large quantities of mollusca, their bodies being floated away by tidal or other currents. If the south-west of England was still land during the deposition of the Neocomian beds, a portion of this old coast may possibly have been in Somerset and Devon.

List of species occurring in the Gault of Black Ven, Dorset; also those found at Golden Cap marked *a*; those in the Folkestone Gault *b*; those in the Cow Stones *c*:

b, c. *Hemiaster asterias*, Forbes.
a. *Pecten quadricostatus*, Sby.
a. *Pecten orbicularis*, Sby.
Gervillia linguloides, Forbes.
a, b, c. *Inoceramus concentricus*, Park.
a, b, c. *Pinna tetragona*, Sby.
a, b. *Lima parallela*, Sby.
b. *Cucullæa carinata*, Sby.
Arca carinata, Sby.
b. *Venus tenera*, Sby.
V. sublævis, Sby.
c. *Panopæa mandibula*, Sby.
b, c. *Panopæa plicata*, Sby.
Cytherea truncata (?), Sby.
Solen Dupinianus, D'Orb.
Pholadomya Fabrina, Ag.
Nucula bivirgata, Sby.
a. *Nucula pectinata*, Sby.
b. *N. ovata*, Sby.
Thracia, n. sp. (?).
b. *Actæon affinis*, Sby.
b. *Cerithium trimonile*, Mich.
b. *Fusus rusticus* (?), Sby.
F. elegans, D'Orb.
b. *F. clathratus*, Sby.
b. *Aporrhais Orbigniana*, P. & R.
b. *Natica Gaultina*, D'Orb.
b. *Pterocera retusa*, Sby.
Turritella Vibrayeana, D'Orb.
b. *Dentalium decussatum*, Sby.
Scalaria Dupiniana, D'Orb.
b, c. *Ammonites splendens*, Sby.
Saurocephalus, sp.

List of species occurring in the Cow Stones of the coast section in West Dorset, and not occurring in the Gault of the same:

Pedopilumnus Fittoni, M'Coy.
Necrocarcinus Bechei, Desh.
Hoploparia longimana, Sby.
Cardium gentianum, Sby.
Lucina pisum (?), Sby.
Modiola, n. sp.
Lima semisulcata.
L. Dupiniana, D'Orb.
Thetis Sowerbyi, Rom.
Trigonia alæformis, Park.
Trigonia scabra, Lam.
Cytherea plana, Sby.
Cucullæa glabra, Park.
Myacites gurgites, Goldf.
Venus immersa, Sby.
Tellina inæqualis, Sby.
Turritella granulata, Sby.
Pleurotomaria Rhodani, D'Orb.
Ichthyosaurus campylodon, Carter, West of Lyme Regis.

III.—ON COLUMNOPORA, A NEW GENUS OF TABULATE CORALS.

By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E.,
Professor of Natural History in University College, Toronto.

Genus COLUMNOPORA, Nicholson.

Gen. Char.—Corallum aggregate, massive, composed of hexagonal corallites, which have distinct walls, but are firmly united with one another. Septa well developed and close-set, but short and not nearly reaching the centre of the theca. A row of large and closely-approximated mural pores between each pair of septa. Tabulæ horizontal, not vesicular or infundibuliform, apparently incomplete. Epitheca unknown. No cœnenchyma.

I have established this genus for the reception of a single species of coral, of which I have seen two well-preserved examples—one collected from the Hudson River Group of Canada by Mr. George Jennings Hinde; the other obtained from the Cincinnati Group (Hudson River Formation) by Mr. U. P. James. The genus *Columnopora* is intermediate in its characters between *Favosites* and *Columnaria*, both of which it resembles in its general form, its prismatic closely-approximated corallites, and the absence of a distinct cœnenchyma. The genus further resembles *Favosites* in possessing mural pores, but it is distinguished from the latter by the possession of very distinct and well-marked septa, and by the fact that the mural pores are arranged in very numerous rows, and are of very large size, so that the walls of the corallites have a regularly cribriform aspect. The genus agrees with *Columnaria*, Goldfuss, in the possession of distinct septa, but is fundamentally distinguished by the perforated walls of the corallites. There is no other genus, save the above-mentioned, to which *Columnopora* is allied with sufficient closeness to render it necessary to institute any explicit or detailed comparison.

The following are the characters of the only species of the genus known to me:—

COLUMNOPORA CRIBRIFORMIS, Nich.

Spec. Char.—Corallites for the most part hexagonal or pentagonal, averaging about one line and a half in diameter, sometimes more or less. Septa in the form of strong vertical ridges, from twenty to twenty-four in number, equally developed, never reaching the centre, or extending more than quite a short distance into the interior of the corallite. Between each pair of septa is a row of large oval or circular mural pores, so that there are from twenty to twenty-four rows of these openings in each corallite, generally about four on each face. Not only are the rows of pores thus extraordinarily numerous, but the pores are of unusually large size, and are placed close together, about three of them occupying the space of one line measured either vertically or transversely. The walls of the corallites thus assume a completely cribriform appearance, and look as if composed of a series of vertical pillars (the septa) united by horizontal cross-bars. Tabulæ, in the specimens observed, imperfect, from three to four in one line.

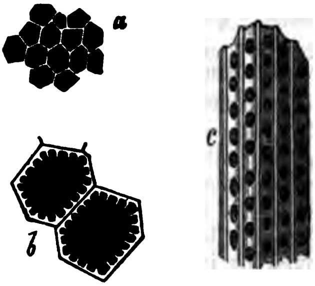

Fig 1.—*a*. A few of the calices of *Columnopora cribriformis*, Nich., viewed from above, of the natural size. *b*. Two of the calices enlarged. *c*. Interior of a corallite greatly magnified, showing the rows of pores between each pair of septa.

At first sight, especially when viewed from above, *Columnopora cribriformis* presents a striking resemblance to *Columnaria alveolata*, Goldfuss; the shape and size of the corallites being alike in both species. The specimens of *Columnaria alveolata* which are found in the Trenton Limestone, so far as I have seen, have, also, short septa, in the form of strong ridges, which extend inwards for a very small distance; and this still further increases the resemblance just spoken of. In the latter species, however, the walls of the corallites are compact, and are not perforated by any pores, and this of itself is a sufficient point of distinction. On the other hand, *Columnopora cribriformis* is distinguished from all the massive species of *Favosites*, both by the well-marked septa and by the large size and enormous number of the mural pores. From *Michelinia*, *C. cribriformis* is separated by the fact that the tabulæ are certainly not vesicular, whilst the pores are much larger and more closely set than in any species of the former genus, and the septal system is at the same time much better developed. In the only specimens I have seen, the tabulæ of *C. cribriformis* are poorly preserved, and nothing is left of them except their bases. This state of things, however, is quite commonly observable in specimens of *Columnaria* and *Favosites*; and I entertain no doubt but that the tabulæ of the present form were really complete and in all respects well developed.

Locality and Formation.—In the Hudson River Group, River Credit, [illegible]io (collected by Mr. G. J. Hinde). In the Cincinnati Group [illegible] *River Formation*), near Cincinnati, Ohio (collected by Mr. [illegible]*es*).

IV.—GLACIATION IN WEST SOMERSET.

By W. C. LUCY, F.G.S.

IN a recent visit to Porlock Weir, to see the submerged forest so ably described by Mr. Godwin-Austen in the Quarterly Journal of the Geological Society for February, 1866, I availed myself of the opportunity, afforded by the limited time at my disposal, to examine the general contour of the country, and more particularly that part of it relating to the superficial deposits.

On the way from Williton Station, *en route* to Dunster, I observed the hills were more precipitous on their north sides, and the flat land at their base was apparently formed of alluvial soil; and on making inquiries of a fellow-passenger, resident in the neighbourhood, he informed me that near Minehead, in a like position to the flat we had just passed at Dunster, when making a well, the shaft went through 70 feet of nothing but gravel and clay, some of the latter very tough, the stones comprising the gravel becoming larger as the sinking became deeper, which, however, did not reach the bottom.

I stayed at Minehead, and walked along the shore to the New Manure Works, ascending thence to the road which skirts the hill towards Greenaley Point. At the top of a little valley was a small coombe, which gradually narrowed, still preserving a half-rounded form, and in which there was sufficient clay left, mixed with some angular detritus, to form soil on which grew a flourishing orchard. The detritus and clay run out to the sea, widening down to the beach, and assuming a spreading wedge-like shape slightly curved inwards, the whole bearing a marked resemblance to what I have seen in glaciated districts. On further ascending the hill are many fields growing corn and root crops, and in some of the fields on a farm at the top of North Hill the soil was much deeper than in the vale. On reaching the summit of the hill I observed several rounded knolls above the general surface of the ground, which were quite bare of soil, forming protruberances very like some parts of the Great Orme at Llandudno. The detrital deposit at the coast at Minehead is a rich loamy soil, formed of the washing down of the New Red series, mixed with angular and small boulders from the Devonian rocks.

The road to Porlock, after leaving Minehead, rises for some distance, and from the highest point of elevation the mode in which the valley was formed by the action of ice becomes evident.

In the middle of the valley is a small hill, which appears to have deflected the ice on its progress to the sea, the greater half going to Minehead, and the other to Dunster. At the end of the North Hill and in other parts the remains of Boulder-clay, clinging to the sides in the hollows, are well indicated by the vegetation which prevails.

All around Porlock Weir the hills sloping seaward suggest that ice has had much to do with the formation of the valleys, and the soil increasing in depth the higher you ascend; and towards the top, looking on to Exmoor, the bare rounded heads of rocks projecting above the surface again occur, as on the hills in the neighbourhood of Minehead.

After leaving Ashley Lodge, Lord Lovelace's residence, about 200 yards along the lower new road and 8 feet above it, resting on the slope, I saw a large mass of sandstone about 5 feet in depth, 4 feet across, and fully 5 feet thick. It presented a smooth appearance and, some rain having just fallen, I at once detected glaciation, and on examination found it well striated.[1] It was only partly detached from the parent rock.

I am not aware of glaciation having been observed before in the district; but on reference to your MAGAZINE,[2] there is a letter from the late Mr. J. Beete Jukes, in Vol. II. page 473 (October, 1865), "Glaciation in Devon and its Borders," relating more particularly to some groovings on the banks of the Exe, near to Barlynch Abbey. He thought they were as striking evidence of glaciation as any in the Killarney or Glengariff counties in the S.W. of Ireland. A year later there was a communication to your pages on the subject of Mr. Jukes's letter, from Mr. Pengelly, who, in company with Mr. Vicary of Exeter, visited the spot referred to by Mr. Jukes, and at the conclusion of his letter (Vol. III. page 574) he says: "We found that so far as it goes Mr. Jukes's description is very correct and indeed graphic, but we found also that he could not have seen anything like all the facts. In short, we were fully satisfied the mouldings were not produced by any kind of ice action." Mr. Jukes replies (Vol. IV. page 41): "I hope, however, that some practised glacial observer may visit the locality some day, and give us the benefit of his opinion upon it. In the mean time, as Mr. Pengelly, in his letter in your last Number, agrees in the correctness of my description of the facts, perhaps he will favour us with his ideas as to their origin, for I certainly have never seen anything like them except on a so-called glaciated surface." This I am not aware that Mr. Pengelly has done.

As an amateur I have seen much of ice-action in Wales and Scotland, and submit that a careful examination in West Somerset would probably lead to the discovery of more glaciated blocks and a greater development of Boulder-clay than are now generally supposed to exist.

It may be presumptuous in me to offer an opinion adverse to that of such able geologists as Mr. Pengelly and Mr. Vicary, more especially as I have never seen the place referred to; but I think it not improbable that Mr. Jukes is right to this extent, that the grooving was caused by ice, but the striæ have been worn away by meteoric abrasion, eating into the rocks, without however destroying the original form of the grooving.

It is well known that even in Wales, except on very hard rocks, like the Cambrian, the striæ are often worn away, although the rounded moutonnéd appearance of the rocks leaves no doubt of their once having been glaciated.

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[1] Some of the specimens which I brought away are deposited in the Taunton Museum.

[2] See also GEOL. MAG. Vol. IX. pp. 177, 574.

V.—On the South of England Ice-sheet.

By James Croll, of the Geological Survey of Scotland.

IN the *Reader*, 14th October, 1865, and afterwards more fully in my papers on the "Boulder-clay of Caithness,"[1] and on the "Transport of the Wastdale Crag Blocks,"[2] the following were shown from physical considerations to be necessary results, viz.:—

1. That were the ice of Greenland much thicker than it is at present, which it evidently was during the Glacial Epoch, it would not float in Davis Straits and Baffin's Bay, and consequently would not break up into icebergs, but would move over upon the North American continent in one continuous mass, and pursue its course southwards, until it gradually melted away under the influence of the Sun's heat.

2. That owing to the shallowness of the German Ocean, that sea during the Glacial epoch must have been filled with land-ice moving off Scandinavia, Scotland, and the North of England, and that this ice in its course must have passed over Caithness, the Orkney, Shetland, and Faroe Islands, and in reaching the deep trough of the Atlantic, would break up into bergs, forming a perpendicular wall similar to that observed by Sir James Ross in the Antarctic Regions.

3. That the ice from Scandinavia must have filled the entire Baltic, a portion of it passing southward over the plains of North Germany, but the greater portion, however, keeping the bed of the Baltic, would cross over Denmark into the German Ocean.

4. And as we know from geological evidence that Scotland during the period of maximum glaciation was entirely covered by a continuous sheet of ice of one or two thousand feet in thickness, it is therefore physically impossible that the North of England could have escaped being in a similar condition.

5. In the paper on the "Transport of the Wastdale Crag Blocks," it was stated that if the summits of the Pennine range were carefully examined, say under the turf, evidence that land ice had passed over them similar to what had been observed by Mr. Bennie and myself on the Pentlands would no doubt be found. These views for several years met with considerable opposition, but they are now beginning to be accepted by geologists.

6. My object at present, however, is more particularly to refer to another result, which at the time appeared equally to follow from physical considerations (which will be more fully detailed on a future occasion), but as it was one so much opposed to prevailing opinions, I deemed it better not to advance it. The result to which I refer is, if we admit that the Great Baltic Glacier, one or two thousand feet in thickness, passed over Denmark, and of this we have good geological evidence, then it is hardly possible to escape the conclusion that a portion of it at least passed across the south of England, entering the Atlantic in the direction of the Bristol Channel. I have little doubt that in the course of a few years the geological objections to a South of England ice-sheet will as gradually disappear, as they are evidently now doing in reference to a North of England ice-sheet.

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[1] Geol. Mag. 1870, Vol. VII. pp. 209 and 271.

[2] *Geol. Mag. 1871, Vol. VIII. page 16.*

VI.—NOTE ON THE OCCURRENCE OF *POLYPORA TUBERCULATA*, PROUT, IN SCOTLAND.

By Prof. J. YOUNG, M.D., and Mr. J. YOUNG, Hunterian Museum, Glasgow.

AS the Transactions of the Academy of Science of St. Louis, in which Prout described this species, are not generally accessible, we quote the description at length.

Bryozoum a fan-like expansion, probably one or two inches wide.

Longitudinal rays moderately large, pretty uniform in size, suddenly enlarged before and after bifurcation; dichotomizing at one, one and a half, near two lines apart; dichotomizing oppositely on two branches from the main branch; stems scarcely diminished one-half by branching, and rapidly attaining their original size.

Dissepiments small, about one-third as large as the rays, about one-third the transverse diameter and one-fifth the longitudinal diameter of the fenestrules, slightly depressed, not expanding much at junction with the rays.

Fenestrules oblong subquadrangular, sometimes shortly spatulate or irregular near the bifurcations, twice as long as broad, slightly broader than the rays, generally opposite. In a space of two lines longitudinally there are three and four-fifths, and transversely five fenestrules; or in five millimetres there are four longitudinally and six transversely.

Cell pores small, round, with thin lips slightly raised above the surface, alternate, their own diameter apart, in from three to six more or less regular lines upon each ray, having a very slightly raised keel between them, and having generally on the middle keel an irregular line of round tubercles, which sometimes intermits, and sometimes shows a disposition to become double. Cell pores five, tubercles three or four to each fenestrule.

Reverse covered by a dense cortical substance, with a few scattered granules.

A species answering to the above description is the most frequent representative of the genus *Polypora* in the Carboniferous rocks of the West of Scotland. To what Prout states one or two additions require to be made. The thin lip of the pores in well-preserved specimens is not circular, but sinks down on the lower edge of the aperture, which thus has a pyriform crater shape. In addition to the ridges mentioned by Prout, the intervening surface is covered with very fine short wrinkles, which are sinuous and sometimes interrupted, so as to give a tubercular aspect. The fronds sometimes attain a size of three inches.

NOTE ON THE MODE OF PRESERVATION OF THE LANARKSHIRE POLYZOA.

In some localities, but chiefly at Hairmires, near East Kilbride, the stems and fronds of several species are covered with a very thin layer of mineral matter, which veils, but does not conceal the sculpture of the surface. The layer likewise extends over the apertures, and may be traced from a narrow diaphragm till it forms a complete operculum. It is most frequently found with a minute central pore. *Weak acid* removes the polyzoon, leaving the incrusting layer intact;

strong acid destroys crust and polyzoon alike; warm water does not dissolve it. The solution with weak acid was found, on testing, to contain sulphuric acid; it is therefore probably a layer of sulphate of lime. The gradual diminution of the aperture seems to point to the chemical origin of the crust, which has crept onward and has not been allowed to complete itself till the death and final decay of the last fragment of the polyzoon had removed the excuse for the infusoria and rotifers which "crept out and crept in." We have not had time to inquire further into the matter; but if any one desires to investigate the nature of this layer, we shall obtain specimens for him. The interest of the question lies in the possible relation which this layer may have to the *Hemitrypa* of Phillips.

VII.—LANDSLIPS AND SINKINGS IN CHESHIRE.

LANDSLIPS are important agents in modifying the surface of the earth, frequently adding to the picturesque appearance of the district in which they occur, and occasionally causing considerable mischief by the destruction of villages, or the covering of fertile ground, as the fall of Rossberg in Switzerland[1] in 1806, and in our own country the landslip near Axmouth,[2] and the undercliff of the Isle of Wight, are familiar examples. They are generally caused by the action of water dissolving or loosening and carrying away some bed low down in the local series, when the upper strata, being no longer supported, break by their own weight, and slide down to a lower level, the amount of their displacement and the rapidity of their movements being determined by the inclination of the underlying beds.

Sinkings or depressions of the surface of the land may originate in a similar manner, or the excavations may be artificially produced. In our coal districts we may frequently observe great alterations of the surface, due to the working of the coal beneath—the levels of roads, railways, and canals are often disturbed, and not unfrequently buildings erected on the surface are destroyed or seriously injured. The extent of the sinking in these cases of course depends on the depth and thickness of the seam worked, and on the resisting power of the beds overlying it.

In the salt districts similar phenomena have been long noticed, and as the salt beds are much thicker than the seams of coal, the effects produced by their removal are greater and more striking. Indeed, so great is the threatened mischief, that the attention of the Board of Trade has been called to it by the Salt Chamber of Commerce, and a thorough official investigation of the facts has been made, resulting in the production of a most important and interesting report by Mr. Joseph Dickinson, F.G.S., which was presented to the House of Commons during its last session.

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[1] The villages of Goldau and Busingen, the hamlet of Huelloch, a large part of the village of Lowertz, the farms of Unter- und Ober-Rothen, and many scattered houses in the valley, were overwhelmed by the ruin. Goldau was crushed by masses of rocks, and Lowertz invaded by a stream of mud. The lives lost were estimated at from 800 to 900. De la Beche, *Geol. Observer*, p. 22.

[2] *Principles of Geology, p. 540.*

The salt deposits of the British Isles are nearly all in the New Red Sandstone district of Cheshire, Worcestershire, and Staffordshire, which furnishes annually nearly one and three-quarter million tons of salt. Salt has also been found near Middlesbrough in Yorkshire, where a bed 100 feet thick has been penetrated; and it is worked near Carrickfergus, in Ireland, from three beds, averaging about 150 feet in thickness, with alternating brown marl and marlstone; but the last-mentioned locality furnishes only the comparatively insignificant quantity of 20,000 tons annually. A portion of this salt is mined as "rock-salt," chiefly at Winsford and Northwich, where the solid bed was discovered in 1670; but the greater part is pumped up to the surface in solution, or, in other words, obtained in the form of artificial brine springs.

The natural brine springs of the district have been used as sources of salt from very early times—the names of the principal towns in it terminating in *wich* or *wych*, being of Saxon origin, *wych* meaning a salt house or salt works. Sharon Turner notices the existence of numerous grants of land made in Anglo-saxon times, in which salt pans are specified as important articles. One of the earliest of these is a grant by Kenulph, King of Mercia, to the Church of Worcester, which bears date A.D. 816. Of the extent to which this industry was carried before the discovery of the salt deposits themselves, we have good evidence in the fact that during the reign of Henry VI. there were 216 salt houses in Nantwich alone.

Thus, for more than a thousand years we know that the waste of the salt beds by the action of water has been going on; and there is no doubt that for thousands of ages, long before there were any men to manufacture salt from the brine springs, the same process was in full activity, especially, as Mr. Dickinson remarks, near the outcrop of the deposits. Here, no doubt, true landslips took place in very ancient times, altering and depressing the surface of the ground, effacing all traces of the outcrop of the salt beds, and giving origin to the meres and mosses which are frequent in such positions, such as the Great Budworth, Pick, and Rosthorne Meres, situated on the outcrop of either the top or bottom bed of rock salt in Cheshire.

Under the present system of working the salt, the landslips or sinkings of the surface take place over the body of the deposit. They are of two kinds, according as they are caused by the solution of the rock-salt to form brine, or by the falling in of old pits. The latter are comparatively of small extent, but the "brine-runs" reach for miles away from the pits, and affect a much wider district, so that the places in which sinkings may occur are quite uncertain, and the depression may, and sometimes does, acquire a great extension, involving considerable risk to property and even to human life. The first recorded sinking caused by the flow of brine took place in 1533. Since that date many similar occurrences have been observed, and there is ample evidence that the movement is still going on. Thus the London and North-Western Railway, where it crosses the brine-runs, has gone down many feet, as between Crewe and Birdwood Junction, and on the Crewe and Stockport line. At Winsford the surface is visibly sinking; the docks have already gone down about ten feet, and the bridge over the river Weaver has again to be raised. In the intermediate parts of the valley the whole surface is being submerged, forming a mere called "The Flashes," and, as the navigation follows the valley, "it is evident," says Mr. Dickinson, "from the surface level being at a considerably less elevation above sea level than the thickness of rock-salt underneath, the subsidence now so actively begun at Northwich and Winsford may end in the whole of this portion of Cheshire being submerged." That this danger is a serious one may be inferred from the fact that the thickness of the salt deposit at Northwich is 180, and at Winsford 210 feet; whilst the elevation of the surface at the former place is only 20 feet, and at the latter place about 40 feet above the sea level; but it is hard to say what measures can be taken to avert what would be a national calamity.

Mr. Dickinson refers to the probability that the contortions observed in strata overlying the saliferous rocks in places where salt is not now known to exist, may be due to the former presence of that mineral, and its having been dissolved and carried away—as, for instance, near Nottingham, in the Lias quarries at Newbold near Rugby, and other places; and he remarks that, although it would be premature to affirm that rock-salt has existed along the entire range of the red marls from Rugby to the Cleveland district in Yorkshire, it is possible that this has been the case, and that many of the landslips which have occurred upon that range may have been due to its removal.[1] J. M.

NOTICES OF MEMOIRS.

I.—The Sub-Wealden Exploration.

THE boring to prove the Palæozoic rocks of Sussex, which was commenced in 1872, is now being carried on with great vigour. The adoption of the Diamond method of boring has proved a great success. Mr. Henry Willett, in his Sixth Quarterly Report, dated March 28th, states that a total depth of 671 feet has been reached. The drill, called the "Crown," is a ring of soft steel 3½ inches in diameter, and has 15 diamonds set in it round its lower edge. It revolves at a speed varying from 150 turns a minute in soft strata, to 300 in hard rock. Water is pumped down the centre, and rising at the sides, conveys the débris in suspension to the surface. The diamonds are not brilliant, and have no cleavage planes; they come from Brazil, and are called "Carbonado." The cores brought up are sometimes six or seven feet long in one piece, and form a beautiful section of all the strata passed through. The fact that delicate shells are found lying at right angles to the axis of the bore, is an indisputable proof that the beds are horizontal.

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[1] As bearing upon this subject, we would refer to a paper by the Rev. J. S. Tute "On Certain Natural Pits in the Neighbourhood of Ripon," Geol. Mag. 1868, Vol. V. p. 178.—Edit. Geol. Mag.

· The following strata have been penetrated:—

	feet	in.
Shales	17	0
Blue limestone	2	0
Shale	5	0
Blue limestone	2	0
Shale	4	0
Limestone	1	0
Shale	4	0
Limestone	3	0
Shale	4	0
Limestone	4	0
Blue shale	16	0
Grey shale	3	0
Hard shale	14	0
Shale with crystals of carbonate of lime	9	6
Grey shale	1	0
Greenish shales with vein of gypsum	20	0
Impure gypsum	9	0
Pure gypsum	4	0
Impure gypsum	8	0
Pure gypsum	3	0
Dark gypsum, impure... ...	13	0
Blue shale	3	0
Gypsum in nodules and veins	13	3
Gypsum marl	8	0
Black sulphurous marl ...	1	0
Greenish sand, with nodules of chert	21	0
Sandy shale, with nodules of chert	38	0
Carbonate of lime veins ...	2	0
Hard sulphurous black shale	12	0
Soft sulphurous black shale	7	0
Hard shale with chert... ...	12	0
Black shale	2	0
Very sulphurous black shale	12	0
Paler shade with gypsum veins	4	0
Dark shale	2	0
Grey shale "Kimmeridge Clay," very fossiliferous ...	378	0

Mr. J. H. Peyton considers that the first 180 feet represent the Purbeck beds, and the next 110 feet the Portland beds.

Mr. W. Topley, of the Geological Survey of England and Wales, who has carefully examined the cores between the depths of 376 feet and 656 feet, says:—

"We cannot be quite certain at what exact depth in the boring the Kimmeridge Clay began, but it was probably at about 290 feet from the surface; this would give 86 feet below the top of the Kimmeridge Clay as the point at which the detailed examination commenced. In the higher part of the Kimmeridge Clay the following fossils had already been noted (by Prof. Phillips, Mr. Willett, and Mr. Peyton):—

Discina (Patella) latissima.
Lingula ovalis
Modiola.
Pecten.
Ostrea.
Lima (?).

"The Kimmeridge Clay, as yet met with, presents but few variations in character. It is nearly all a very dark grey or blackish clay, generally rather sandy and calcareous. Some specimens, which were preserved from about 330 to 350 feet from the surface, are rather hard, and show no tendency to split up. Those from about 380 feet, downwards for about the next 100 feet, can only be preserved with great difficulty; the clay is soft, and the cores split up into numerous laminæ, generally breaking at the places where fossils are preserved. Fossils are very numerous in this part, and it is, perhaps, partly owing to this that the cores break up so readily; in the higher and lower parts, where fossils are generally much less abundant, the cores do not so easily break.

"At 500 feet from the surface (and for a few feet below) the cores are hard, and break with a slightly conchoidal fracture; this is again the case at 640 and 650 feet. But the only important deviation from *the usual clayey* character of the bed is a hard, tough, rather sandy, and calcareous stratum, of a light grey colour, which occurs at from 600 to 602 feet. This, when slightly warmed or struck, smells very strongly of petroleum. At 604 feet there is again about 6 inches of hard clay with similar characters.

"Slight indications of petroleum have been noticed all through the Kimmeridge Clay, but they become more distinct at about 160 feet from the top of the clay (or about 450 feet from the surface); all below that depth is more or less impregnated with petroleum, it being particularly abundant at the following depths (from surface) —600, 604, 617, 622, and 651 feet. Fossils are scarce, or absent, in those parts of the clay which are richest in petroleum.

"Occasionally there have been veins of carbonate of lime crossing the core obliquely; these were especially abundant at 480 and 549 feet. The core readily breaks along these oblique lines. Some of the strings of carbonate of lime are scarcely visible to the eye; at first it appears as though the beds in these parts were dipping at considerable angles, and that the cores break along the lines of bedding. But this is not the case; all the beds yet passed through are horizontal.

"A list of the fossils hitherto observed is given below. Mr. R. Etheridge, F.R.S., has kindly looked over some specimens about which I felt doubtful; the list of generic names here given may, therefore, be taken as correct. When more specimens have been collected, and time allows, we shall, no doubt, be able to add the specific names to many. We seldom, however, obtain perfect shells, and very frequently the part missing is just that part which is required in order to determine the species.

"It has not yet been possible to make out any distinctive zones of life, correlating the Kimmeridge Clay of the boring with that known elsewhere. Even when all the cores are thoroughly examined, and every species fully tabulated, this will be at best a very uncertain task, for it is never safe to infer the *absence* of any fossil, at certain horizons, from an examination of a vertical section only two inches in diameter.

"The comparative abundance or scarcity of certain shells is, however, worth recording. *Trigonia* and *Alaria* are exceedingly rare; *Ammonites biplex* is tolerably abundant all through; *Cardium* also occurs all through, but most commonly in the higher part; *Modiola pectinata* occurs all through the clay, but in the upper part the shells are small, and it is only in the lower part that full-sized specimens have been obtained; the same remarks apply to *Lingula ovalis*.

"The horny shells of *Discina* and *Lingula* are well preserved; and so, too, are the shells of *Ostrea*, *Pecten*, and *Belemnite*. The shells of *Ammonites*, *Modiola*, *Cardium*, and *Astarte*, are generally less perfectly preserved; whilst *Arca*, and some others, occur only as impressions, but all the markings are plainly visible.

"In the following list it will be seen that *Gryphea virgula*, the shell so especially characteristic of the Kimmeridge Clay, is absent. Although this shell has been carefully searched for, not one specimen has yet been observed. In the Bas Boulonnais *Gryphea virgula*, whilst occurring all through the Kimmeridge Clay, is especially abundant in the lower part. The absence of this in the boring, whilst other shells are so remarkably abundant, might lead us to fear that there is yet a good deal of Kimmeridge Clay to come. On the other hand, it should be remembered that at Weymouth, as Mr. Bristow informs me, it is the lower part of the Kimmeridge Clay which yields the most petroleum; and as we are now well down in the oil-bearing beds, we may hope that the base of the clay is not far off.

"List of Fossils from the Kimmeridge Clay of the Sub-Wealden Boring:—

Discina (*Patella*) *latissima.*
Lingula ovalis.

Arca.
Astarte Hartwellensis.
A. aliena, Phil.
Cardium striatulum, Sow.
C. ? sp.
Exogyra nana, Sow.
Lucina (? young forms of *L. Portlandica*).
Modiola.
Myacites.
Ostrea deltoidea (?), Sow.
Ostrea ? sp.
Pecten arcuatus, Sow.
P. (a form with coarse ribs).
Thracia depressa, Sow.
Trigonia.

Alaria.

Ammonites biplex, Sow.
Belemnite.

Hybodus (tooth).
Fragments of fish bones.

"W. Topley."

According to Mr. Bristow, the Kimmeridge Clays, near Weymouth, have been ascertained, by actual cliff measurement, to be 530 feet thick. They are supposed to thin out towards the east, and at Netherfield will probably not exceed 400 feet, of which 360 feet have been already pierced. Mr. Willett states that during the last quarter, gypsum beds, which would probably never have been known but for this scientific enterprise, have been sought for and found at Archer's Wood, on the estate of the Earl of Ashburnham, who was the earliest patron and one of the most munificent donors to the Fund. A shaft for verifying and working the gypsum beds has also been commenced upon Mr. Egerton's estate, within a few yards of our shed, just across the stream. It is a matter of congratulation that by this discovery there has been developed for Sussex a new industry, which promises to be highly remunerative to all parties.

Mr. Topley speaks of the classification of those rocks formerly known as the Ashburnham beds, and which consisted of those clays which formed the cliffs of Fairlight. It was at one time very doubtful whether the Geological Survey should give this name to the strata in the interior of the country near Battle, and when the gypsum was discovered there, it decided them what to do, as they did not find gypsum in the Weald proper. They resolved to call the beds in the country near Battle the Purbeck beds, and to keep the strata on the coast about Hastings in the Wealden, and they now called them the Fairlight clays. H. B. W.

II.—On the Antiquity of Mining in the West of England.

By R. N. Worth, Esq.[1]

THE author said the inquiry into the antiquity of mining in the West of England naturally divided itself into three branches —the historical, the inferential, and the geological. The historical records of their own country showed that long before the date of the first existing Stannary Charter, that of John, A.D. 1201, tin mining in Cornwall and Devon was a settled and organized occupation. Greek and Latin writers about and before the Christian era made frequent reference to the existence of a trade from the East for tin with the Cassiterides, carried on by the Phœnicians. In proof of this, the writings of Diodorus Siculus, Strabo, and others were cited. The earliest direct evidence was that given by Herodotus, who, writing in the fourth century B.C., stated that tin was brought from the Cassiterides, but that he did not know where the Cassiterides were. It was clear, however, that under that name parts of Cornwall, if not Devon, were intended, and hence a definite recorded antiquity was given to the mining of the West of at least 2300 years. The use of metals by man clearly pre-supposes the existence of some kind of mining. Tin and copper were two of the oldest metals known, and were mentioned either by their separate names or under the title of bronze in the very oldest writings—in Homer, Hesiod, and in the Pentateuch, the 'brass' of which was really bronze. Prehistoric archæology gave a high antiquity to what was known as the Bronze Period, which in Switzerland had been considered to date back 4000 years. Mr. Worth was inclined to agree with the position of Sir John Lubbock, that the use of bronze in Europe originated with an Indo-European race, and could not accept the theory that bronze was first produced in the West of England by the smelting of mixed metal ores. Given the antiquity of the bronze age, the next point to be decided was, whence the tin used in its manufacture came. He held that so far as Europe was concerned, the balance of evidence—tin being a metal which occurred nowhere in Europe in large quantities save in the West of England—was overwhelmingly in favour of Cornwall and Devon. The examination of the third branch of the inquiry—the geological—was prefaced by an explanation of the different modes of occurrence of tin ore, in lodes or in detrital deposits; and the manner in which the one was wrought by mines and the other by streaming—the latter the oldest form of tin mining practised. The oldest streamers of which they had any knowledge had no other implements than a pick of wood or horn and a wooden shovel—many of which had been found in old workings. It was entirely due to the fact that streaming was the oldest method of raising tin ore that they were enabled to form any far-reaching conclusions as to its antiquity. There was not a valley on the South Coast of Cornwall—at all within the mining area—that had not been streamed again and again; but nowhere had the stream works been so extensive and important as at Pentuan and

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[1] Being the substance of a lecture delivered on March 5th at the Plymouth Athenæum.

Carnon. In 1829 Mr. J. W. Colenso gave the Royal Cornwall Geological Society a description and section of the Happy Union stream work at Pentuan. Here, at a considerable depth under beds of gravel and silt, the result of both marine and fresh-water deposition, there were found the remains of an ancient forest growing upon and out of the stratum which contained the tin stones, the trunks of many of the trees being *in situ*. This was thirty-four feet below the level of the sea at low water springs. A piece of wood shaped by man was found twelve feet above, and twenty feet above that again the bones of a whale of an extinct species, and human skulls. Higher up the valley, in Wheal Virgin stream-work, at a point where the tin ground was still below the level of the sea, it was found to have been worked. About the same time Mr. W. J. Henwood, F.R.S., communicated to the same Society a paper on the "Deposits of Stream Ore in Cornwall,"[1] which contained sections and descriptions, amongst others, of the stream-works at Carnon. The sections in the two valleys, though differing, presented the same general characteristics; and whereas at Pentuan human remains were found 40 feet below the surface—34 feet below high-water—at Carnon they were discovered at a depth of 58 feet—64 below high-water. And as at Pentuan traces of the "old men's workings" were found below the tide level, so at Carnon, at a depth of 40 feet, there were disinterred a wooden shovel and a deer-horn pick. Although a mound would have been required to prevent the influx of the tide in working this spot, no traces of such an erection were discovered. De la Beche held that the discoveries at Pentuan and Carnon proved that a considerable change had taken place in the relative levels of sea and land since man inhabited Cornwall. The mere fact of the occurrence of traces of human existence and industry at a certain depth in valley deposits did not of necessity imply any great antiquity. The special industries of Cornwall had caused large quantities of *débris* to wash down; but the deposits overlying the traces of ancient mining operations at Carnon and Pentuan, were, in Mr. Worth's opinion, indicative of a gradual formation. They were fluviatile, estuarine, marine, possibly lacustrine also; and to the geologist they indicated the lapse of considerable time, changes of level, and other alterations of condition. After contending that the remains to which he directed attention were clearly antecedent to the deposits, Mr. Worth said that in that case they were driven to one of two conclusions—either the ancient miners must have worked beneath the level of the sea, or whereas the tin bed was now beneath the sea-level, at the date of these operations it must have been above. The first supposition did not require examination. There were evidences of geologically recent and gradual changes of level all along the coasts of Devon and Cornwall in the raised beaches which were found 30 feet or so above the beaches now existing, and in the submerged forests so frequently discovered, which showed that since they flourished the land had sunk at least 70 feet. These grew immediately on the tin ground in Carnon and Pentuan, and during the forest epoch, therefore, the tin ground could have been worked at surface. Unless the premises were wholly incorrect, tin must have been an object of search in Cornwall when the now submerged portions of these ancient forests had not disappeared wholly beneath the waves. When was this? The positive evidence was small. The Mammoth existed during part of the forest period, but the submergence was so gradual that it was not absolutely needful to hold that there were miners contemporaneous with the Mammoth. But there was some valuable negative evidence in the fact that the level of England could be proved to have remained unaltered since the days of the Roman occupation. The fact, too, that St. Michael's Mount still answered to the description of the Iktis of Diodorus Siculus, was another proof that the subsidence of the forests and the accumulation of the bulk of the overlying deposits must have occurred long before. The general conclusions tended to show: that the historical evidence of the antiquity of Western mining carried it back at least 2,300 years; that the inferential evidence nearly, if not quite, doubled that period; that the geological evidence antedated its commencement to a time when the Mammoth either still existed or had not long disappeared, and when the general level of Cornwall and Devon was at least 20 to 30 feet higher than it was at present.

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[1] See Geol. Mag. April, 1874, p. 177. Also, Journ. Royal Inst. of Cornwall, *Truro, No. xv. 1873.*

III.—BRIEF ABSTRACTS—A. MINERALOGY.

1.—ON PSEUDOMORPHS OF ROCK-SALT FROM WESTEREGELN. Uber Steinsalz-Pseudomorphosen von Westeregeln. Von Herrn E. WEISS, in Berlin. *Zeitschrift d. Deutschen Geologischen Gesellschaft.* Band xxv. 1873, Heft 3, pp. 552–561.

TWO shafts sunk for working rock-salt near Westeregeln, N.W. of Stassfurt, in Prussian Saxony, have yielded the pseudomorphs described in this paper. A collection of specimens of the various rocks pierced by the shafts has been presented by Mr. Douglas, of Westeregeln, to the Mining Academy of Berlin, and it is on these specimens that the present communication is founded. The pseudomorphs are of two distinct kinds: the one a pseudomorph of rock-salt after rock-salt, the other of rock-salt after carnallite. A section of Shaft I. shows that the crystals were found chiefly in beds of saliferous clay at a depth of about 125 meters from the surface.

The pseudomorphs after rock-salt present the appearance of small white, yellow, or pale-red cubes, more or less distorted or elongated, and frequently with oblique angles, so as to resemble rhombohedra. However irregular the angles, the crystals may always be readily cleaved into laminæ in three rectangular directions, representing the ordinary cubic cleavage of rock-salt. The external surface of the pseudomorphs is formed by a very thin layer of quartz which remains behind, as a hollow shell, when the salt is removed by solution. The history of these pseudomorphs is thus interpreted by the author: the salt originally crystallized in the form of true cubes scattered through a matrix of soft clay; these crystals were then dissolved out, leaving cubic cavities which were afterwards distorted either by displacement or by contraction of the surrounding clay; quartz was then deposited on the walls of the cavities, as a thin layer of crystals, having their apices directed inwards; and, finally, a solution of chloride of sodium was introduced into these drusy cavities, which thus became gradually filled by a second deposit of salt. There are reasons for supposing that in most cases the original cube of rock-salt was not completely removed, but that a fragment remained in the cavity, and served as a nucleus for the second deposition.

The pseudomorphs of rock-salt after carnallite occur chiefly in a bed of clay immediately below that which yields the other pseudomorphs, but in some cases the two kinds are associated in the same bed. The crystals present forms characteristic of carnallite, and are coloured red by the presence of ferric oxide.

The following analyses show the composition (I.) of the white pseudomorphs after rock-salt, and (II.) of the red pseudomorphs after carnallite. The salts were dissolved in water, with addition of a little nitric acid; the insoluble residue consisted chiefly of silica, with a small proportion of ferric oxide and alumina.

	I.	II.
Residue	16·92	4·24
Chloride of Sodium	63·71	90·35
Sulphate of Calcium [1]	8·97	1·46
„ Sodium	2·94	0·24
„ Magnesium	1·66	1·04
Ferric Oxide and Alumina	0·92	0·83
Loss (water)	4·88	1·84
	100·	100·

F. W. R.

Brief Abstracts—B. Geology.

2.—Taylor, J. E. A Sketch of the Geology of Suffolk. From White's History, etc., of the County, pp. 13. Large 8vo. *Sheffield*, 1874.

An account of the literature of the subject is first given, and then the geological formations are described, in ascending order, beginning with the Chalk, the places where it crops out being noticed, and also the various depths at which it has been found in wells. The Reading Beds and London Clay follow next, and many sections are named. The "Box Stone Deposit" is then described; it underlies the Crag, and is characterized by containing many large flints, foreign boulders, and brown water-worn sandstone masses, which last often contain casts of shells, that are disclosed by a sharp blow; and it is now concluded that these stones are the remnants of a deposit older than the Coralline Crag, to which they were once thought to belong. The peculiar Suffolk formations, Coralline and Red Crags, with their chief sections, are noticed, and followed by accounts of the Norwich Crag, Chillesford clay and Forest-bed, a description of the sandy gravels and clays of the Lower and Upper Glacial Drifts and of the Post-Glacial beds concluding the essay. W. W.

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[1] *The sulphates are calculated as anhydrous salts.*

3.—**Kerr**, C. M. An Excursion of Mr. Wilson's Geological Class to Mount Sorrell. *Rep. Rugby School Nat. Hist. Soc. for* 1873, pp. 7–9. [1874.]

The soil produced by the decomposition of the syenite was noticed to be thick, and there is also Glacial Drift. Some of the sections are briefly noticed. W. W.

4.—**Wilson**, J. M. The Rugby Drift. *Rep. Rugby School Nat. Hist. Soc. for* 1873, pp. 10–13. [1874.]

The cutting on the London and North-Western Railway between the Station and Clifton-road showed Drift over Lias, the former consisting, in ascending order, of a foot of clay full of chalk-pebbles; three to five feet of clay with little chalk; a sandier clay with pebbles of quartzite and of chalk; and at top sand and gravel. The author then enters into the question of the glacial origin of the beds, and the direction from which the materials must have come, and concludes that all the drift is the result of one process, while the land was sinking, the materials being derived at first from the neighbourhood, and then from greater distances. W. W.

5.—**Mann**, E. Geological Expedition to Atherstone and Nuneaton. *Rep. Rugby School Nat. Hist. Soc. for* 1873, pp. 19–22. [1874.]

Notices sections of Millstone Grit, with intruded greenstone. W. W.

6.—**Oldham**, Dr. Coal Fields of British India. *Rep. Rugby School Nat. Hist. Soc. for* 1873, pp. 45–54.

The lowest formation in India is gneiss, with trap-dykes of great length. This is succeeded by the schistose and quartzitic *Kuddapa* rocks, above which an unconformity occurs, and the overlying rocks have various local names. Above these comes the Vindhyan series (sandstones with limestones and clays), of great thickness and area, probably of "Old Red" age, and of freshwater or estuarine origin. There is then another unconformity, and the succeeding thick series of sandstones and shales is marked by the occurrence of terrestrial plants. The lowest part of this "plant-bearing series" is the Talcheer beds, consisting of fine silt with large blocks of rocks from distant localities, which have been transported by ice, as some show glacial polishing and scratching. To the Talcheer beds succeed the Damuda beds (10,000 feet thick), which contain all the productive coal, and consist of ironstone-shales, sandstones, and coals, the last varying up to thirty-five feet in thickness. Westward the coal-bearing rocks change in character, some divisions dying out, and the coal being concentrated in a few thick beds.

The coal-fields are in basins, largely owing to original limitations of deposit, and not merely to denudation. They are in groups related to the great drainage courses, which seem to have been marked out at the time of the deposit of the coal-bearing beds. All the coals consist of fine layers of vegetable matter and silt, and are less mineralized than most English coals; their age has been wrongly *given as Oolitic* and Carboniferous (plants being the only fossils); but from the probable Triassic age of certain overlying beds, they may be partly Permian and partly Carboniferous.

W. W.

7.—MAXWELL, L. Geological Section (Report of). *Rep. Rugby School Nat. Hist. Soc. for* 1873, pp. 64, 65 (Plate).

Three sections of "the Oolitic Drift at Brownsover" are given. The beds are gravel and sand, arranged in a sort of basin. Four other sections in gravel, sand, and clay (Bilton), are noticed. W. W.

8.—ANDERSON, J. On the Geological Formations of the County Down. *Proc. Belfast Nat. Hist. and Phil. Soc. for the Session* 1871–72, pp. 41–49. [1873.]

The author gives a general sketch of the geology of County Down. He points out that the Keuper and Bunter divisions of the Trias appear conformable. He disputes the identification of certain Permian rocks at Fortwilliam and Cultra, considering them to be of Carboniferous age. The Carboniferous and Silurian rocks are referred to, as likewise the igneous dykes, and some rocks supposed to be of Cambrian age. The mineral veins are briefly alluded to, and lastly the author points out some of the later changes in the physical geography of the district. H. B. W.

9.—MACPHERSON, J. Geological Sketch of the Province of Cadiz. 8vo. pp. 59. Cadiz, 1873.

The author first describes the physical geography of the district, and then points out the general features of the Secondary rocks. These form three distinct series, perfectly well defined by their respective faunas. The lower one is formed by strata which belong to the Liassic formation; in the second organic remains are found, which prove it to belong to the Upper Jurassic series; whilst in the third, beginning with the fauna of Stramberg, the strata terminate with true Neocomian deposits. Eocene, Miocene, Pliocene, and recent deposits are briefly described. Gypsiferous rocks form a broad belt, which traverses the entire province; the author hints at their possible Triassic age, but "is more inclined to consider these deposits as the result of a profound epigenesis which has taken place since the Miocene epoch." Salt and sulphur springs are numerous in the region, and there are some mud-volcanos in activity.

The work is accompanied by several plates of sections, which the author describes, pointing out the nature of the disturbances which have taken place; and indeed the structure of the country as displayed in these sections is one of numerous undulations.

A geological and an isometrical map accompany the paper, and it is interesting to compare the two: there is hardly any connexion between the geological boundaries and the contour-lines, owing to the great disturbances that have taken place, and the vast denudations that have succeeded them. H. B. W.

10.—YOUNG, R. Some Remarks on the Recent Changes of Coast Level at Ballyholme Bay, Co. Down. *Proc. Belfast Nat. Hist. and Phil. Soc. for the Session* 1871–72, pp. 39–40. [1873.]

A section of the Post-Tertiary beds exhibited at Ballyholme Bay *is described.* These comprise, first, Boulder-clay, which rests on the Lower Silurian slates; for a short distance it occupies a horizontal position, and then sinks gradually below the beach. Above the Boulder-clay, and resting conformably upon it, is a bed of dark sandy mud, which likewise dips under the beach. At low water, and when a storm has removed the loose shingle, portions of trees, mostly of the alder and willow, are to be seen imbedded in the upper surface of the mud. The author considers that there must have been a greater elevation of the land at the time when the trees were growing, to the extent of at least eight feet above the present level, and that subsequently a subsidence to the extent of at least thirty feet took place, and again an elevation to the level at the present time. H. B. W.

BRIEF ABSTRACTS—C. PALÆONTOLOGY.

11.—WINKLER, Dr., Mémoire sur des Dents des Poissons de Terrain Bruxellien. In the *Archives du Musée Teyler*, vol. 3, part 4, 1873.

Dr. Winkler gives a list of 44 species of fish teeth belonging to the Sharks and Rays, from the Terrain Bruxellien (Middle Eocene) of Belgium, of which five are new and fully described in his memoir, viz.: *Corax fissuratus*, *Galeocerdo recticonus*, *Otodus minutissimus*, *Lamna gracilis*, and *Plicodus Thielensis*, the latter being a new genus belonging to the Cestracionts, and closely related to the genus *Orodus* from the Carboniferous Limestone of Bristol, but of which no intermediate or similar form has been found in the long series of intervening strata. J. M.

12.—MACLOSKIE, Rev. Dr. G. The Silicified Wood of Lough Neagh, with Notes on the Structure of Coniferous Wood. *Proc. Belfast Nat. Hist. and Phil. Soc. for the Session* 1871–72, pp. 51–65. [1874.]

The silicified wood is found in the drift deposits at Sandy Bay and other places inland, on the eastern and northern borders of the Lough; it is only found on the beach on the western side of the water. In certain places near Sandy Bay the silicified wood has been found in connexion with lignites, but it is not co-extensive with them, nor does it, like them, occur intercalated between the masses of trap rock. The author considers that there is an intimate connexion between the silicified wood and the lignites of Antrim, and that the former is probably a representation of Miocene vegetation.

The original wood was coniferous, of the type *Cupressoxylon*, and may have been of the genus *Sequoia*, but this is uncertain. The process of silicification was, in Dr. Macloskie's opinion, probably due to cold water holding silica in solution; a rapidly running river containing silica in solution, and having logs of trees in its channel, would, he thought, afford favourable conditions for the production of silicified wood. In conclusion he pictures the conditions under which these remarkable fossils may have been deposited in the positions in which they now occur. H. B. W.

REVIEWS.

I.—The Moon.[1]

THE work of which the title appears below is a magnificent contribution to the study of the phenomena of our satellite, illustrated by most interesting and instructive photographs of the entire visible disc and magnified portions of its principal features. The accompanying verbal descriptions, and the disquisitions on the character and probable origin of these features, are given with a fulness of detail and clearness of style which cannot fail to render the work acceptable to both the scientific and general public. I will not, however, pretend to review such a work in its entirety, for which the limits to which I must confine myself would not suffice. But it may be allowed me, perhaps, to notice briefly such portions as bear upon the seemingly volcanic character of the lunar surface, and may possess an interest to the readers of the Magazine.

It is now fifty years since, upon my reading a paper to the Geological Society on the Phlegræan fields near Naples, illustrated with a sketch-map of its several crater-hills, Sir John Herschel, in the discussion that followed, expressed his conviction that many portions of the moon's surface must have had a similar volcanic origin. And he subsequently declared that the lunar mountains "expressed the volcanic character in its highest perfection." Nevertheless there exists sufficient difference between the volcanic manifestations in the two planets to justify the opinion of a corresponding difference in the conditions under which they were produced, and to render their comparison an interesting subject of study to geologists, no less than selenologists. Having myself paid special attention to the phenomena of terrestrial vulcanicity, I will venture to offer some remarks that suggest themselves in reference to the diversities alluded to above, and their probable causes.

1. *Lunar craters.* No one can have examined the moon's surface with a telescope of even moderate magnifying powers without being struck by the prodigious number of crater-like hollows with which it is pitted, as thickly as ever was a human face with the marks left by the small-pox. They are in fact countless, and of all sizes, from circular or nearly circular plains—20, 30, even 70—and if the larger dusky spaces usually called seas are to be also reckoned as craters, from their approximating to a circular outline—more than 300 miles in diameter, each surrounded by ramparts often several thousand feet in height, generally precipitous towards the interior, but having rugged outer slopes—down to cones so minute as to be almost invisible even with the aid of the most powerful instruments, each likewise encircling a cup-shaped hollow. These minor craters are generally arranged in lines, often radiating from some central point on which the eruptive force seems to have been exceptionally violent.

The other characteristic features of the lunar disc, as described by

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[1] The Moon, considered as a Planet, a World, and a Satellite, by James Nasmyth, *C.E., and James Carpenter*, F.R.A.S. (John Murray, Albemarle Street, 1874.)

MM. Nasmyth and Carpenter, and exhibited in their photographs, are (2) plains and plateaux, superficially more or less smooth, suggesting the idea of the consolidated surface of a sea of mud or lava, upon which the innumerable cones and craters already mentioned are profusely scattered. (3) Mountains, often occurring singly in the centre of the crater rings, not unfrequently, however, having several distinct peaks, and in some cases, but not many, rising from the plains in rough wrinkles or linear ranges. None of these eminences show any signs of craters upon their summits or sides, as is generally the case with the volcanic mountains of our globe. (4) Bright but narrow streaks, usually radiating from some conspicuous crater in all directions, and to distances of many hundred miles. These streaks pass over all the other superficial features without disturbing them, and rise so slightly above the surfaces they traverse as to cast no shade on either side, however obliquely the sun's rays strike them. Indeed they are only visible when the light falls directly upon them. They convey the impression of having been cracks in the already consolidated surface, starred by internal expansion, from which liquid matter has exuded throughout their whole length, and overflowed their edges, but without spreading laterally to any distance. (5) Other evident cracks, narrow but deep, and to all appearance empty, which likewise traverse large portions of the lunar plains, and sometimes cut through a mountain range.

These features are on the whole not very dissimilar from those observable in volcanic districts on our earth's surface. The resemblance at least is sufficiently close to justify the general notion that they have been produced by forces analogous to terrestrial vulcanicity. The differences, however, suggest proportionately different conditions under which volcanic action has operated on the respective surfaces of the two planets.

For example, while the volcanos of our earth are, as a rule, and appear always to have been, intermittent in their activity,—intervals of quiescence usually alternating with periods of eruptive violence from the same vent, so as to produce in the result a conical mountain with a crater on its summit,—not a single instance of this kind, as has been already noticed, is to be met with on the moon. Craters there are, as has been said, in numbers, encircled by ramparts of varying heights, in some cases reaching 15,000 feet from their base. But the area inclosed by these circular ranges is too large to admit of the whole elevation bearing any resemblance to a volcanic mountain, the result of repeated eruptions, like Etna, the Peak, Cotopaxi, Chimboraso, Ararat, Fusiyama, etc. It would seem that each of the lunar craters was the product of only a single eruption, as in the case of the Phlegræan fields, the Puys and crater-lakes of central France, the Eifel, etc.. —the craterless hills which so often rise in the centre of a lunar crater having been the final product of the eruption which hollowed it out, and threw up the encircling rampart, thus corresponding to the domes or bosses of trachyte sometimes found in the interior of *terrestrial craters*, such as Astroni, Rocca Monfina, the

Puy de dôme, Sarcouy, etc. These central cones, however, in the moon never rise to the height of the encircling ramparts. Indeed so far from there being any signs of recurring activity among the lunar volcanos, the close packing of such a vast number of craters over nearly the whole surface of the moon, frequently touching, but rarely interfering with one another, goes far towards accrediting the belief that they were all in eruption at the same time, or, at least, within the same very limited, and that probably a very early period of our satellite's existence. It seems certain that while the processes which have communicated such infinite variety to the surface relief of our globe, and are still performing the same useful function, have always been in active operation, those which produced the configuration of the moon were only in activity at a time incalculably remote from the present, and have remained inactive ever since; that while the former is and always has been undergoing continual superficial destruction and renovation, almost resembling the phenomena of life in an organized being, the latter has been since the date of its eruptive activity absolutely inert and inanimate, an extinct planetary body, destitute alike of organic life and even of inorganic movement, internal or external, active or reactive.

Such indeed would seem to be the necessary result of the absence of any atmosphere, as well as of water, upon the moon's surface—a fact which can hardly be called in question as respects the present time, seeing that no clouds or vapour have ever been detected there, such as could not fail to be produced in abundance by the exposure of any superficial moisture to fourteen days of continual sunshine. That the same condition has existed from the first, or at all events since the formation of the present surface of the planet, is also rendered almost certain by the non-existence there of any marks of erosion or denudation. The absence of an atmosphere and of water by eliminating all meteoric agencies must, from the first, have deprived the moon's surface of any covering by sedimentary and transported materials, such as compose so large a portion of our earth's outer envelope, and by their low conductivity greatly reduce the rate at which its internal heat escapes by radiation into space. The fact that no change has been observed by reliable authorities in the superficial features of the moon through the last two or three centuries likewise offers some assurance of the complete cessation at present of all intestine movements affecting its crust, of the character of those which we know to be continually disturbing the face of our planet. Thus, though we may conjecture that the origin of both was the same,—viz. from the condensation of nebular matter,—it is evident that, through some cause,—whether its comparatively small volume and gravitating force, or its alternate exposure for fourteen days together to extremes of superficial temperature due to solar heat, probably ranging from 300° F. above, to 200° F. below freezing-point, or the excentricity of its axis of rotation, or other unknown circumstance,—the present condition of the moon is very dissimilar from that of our earth, and the analogy *observed in some* of its main features must not lead us to infer that they were produced under precisely similar conditions. Indeed, under the conditions which seem to have prevailed from the first in the moon it is possible to imagine that our globe itself might have appeared less dissimilar to its satellite in outward aspect than it is at present, the agents of its external change being confined to those of volcanic order. Nay, it is conceivable that its rate of cooling due to the loss of heat by radiation into outer space would, in the absence of any external coating of sedimentary rocks, water, or air, have been so infinitely quicker that it might have long since assumed the inert and lifeless character of the moon itself—its internal heat exhausted, a spent planet. From this terrible fate it seems that we have been hitherto preserved by the continual play of opposing forces, from within and from without, secured to our earth by its aqueous and aerial envelope.

Assuming, however, the surface matter of the moon to be more or less of the nature of our plutonic and volcanic rocks, and to have been consolidated from a condition of igneous fusion, which seems on cosmical grounds to be reasonable, the question remains, what was the character of the eruptive forces to which the peculiar features of this surface are owing? Were they identical with or even similar to the volcanic action which has operated on the crust of our globe? and if any difference is to be suspected, in what does it consist, and in what may we suppose it to have originated? An inspection of the portions of the lunar surface so ably photographed in the work before us supplies some help towards the elucidation of this problem.

It is difficult, upon such inspection, to resist the impression that the main features of the moon's face are due to the sudden, rapid, and violent ebullition of a liquid surface, occasioning the repeated rise upon numerous points, from the heated interior, of volumes of immensely elastic vapour (bubbles I would call them, after Hooke), the explosion (or bursting) of which exercised a powerful dispersive force upon the superficial liquid matter, propelling it outwardly on every side, both in spattering jets, and in concentric waves—the matter thus driven away from the vent consolidating rapidly into an annular bank or rampart around it at a radial distance determined by the violence of the explosions.

The subsequent more tranquil emission of the liquid matter beneath, through the vent-holes thus established (a common occurrence among terrestrial volcanos), as well as from cracks caused by deeper internal intumescence, or by the hydrostatic pressure of the gradually contracting shell, will account for the partial or complete filling up of the craters with lava, followed by its frequent outflow from their breached sides; as likewise for the still later exudation of more viscid matter both from the central vents and from fissures producing heaped up mountainous excrescences, as well as the bright streaks described above; while the complete consolidation and consequent shrinkage of the surface will have given rise to those rectilinear empty cracks which seem to indicate the last phase of the process.

A view to some extent similar to this is advocated by MM. Nasmyth and Carpenter. They, however, endeavour to account for "the violent ejection of the matter underlying the solidified crust of the moon," by a force derived "from the expansion of a solidifying substratum, *without having recourse to aqueous or gaseous sources of eruptive power,*"—a process which does not appear very intelligible. It is undeniable that the production of volcanic mountains, and still more of craters, upon our earth, is due to the eruptive forces of some elastic vapour or gas (chiefly, if not solely, steam). If, therefore, we are to believe in any analogy between terrestrial and lunar volcanic action, we cannot dispense with the influence of the outburst of elastic vapour from the surface of the moon in the production of her craters. I cannot indeed conceive the violent ejection and dispersion of fragmentary or of liquid matter to horizontal distances of many miles—which is required in the theory of these authors—by the mere escape of liquid from a vent, unaccompanied by any explosive force. The phenomena of Kilauea perhaps offer the nearest approach to an example of inexplosive volcanic action. And the authors of the work before me modestly express some doubt whether Dana's reference of the formation of the lunar craters to a similar process, *i.e.* to the mere circular spreading of heat from the centre of an ebullient lava surface, be not more plausible than their own theory. But Kilauea is a very exceptional case among terrestrial volcanos. Its crater is a lateral aperture or well, kept open by the rather tranquil boiling up of what may be called a spring of lava in its centre. It lies low down on the flank of a dome-shaped volcanic mountain (Mauna Loa), which rises 10,000 feet above it, and is frequently in eruption, so that the column of liquid lava in this main vent may be supposed to supply that which wells up in the lower branch of the syphon. There is no bank or annular rampart on the outside of its inner cliffs. On the whole Kilauea bears little or no resemblance to the normal type of lunar craters.

Nevertheless the peculiarities of these craters do seem to me to suggest some deviation from the ordinary explosive action of terrestrial volcanos, to which the formation of the vast crater-rings of Madeira, Teneriffe, St. Helena, Santorini, etc., are clearly attributable. These are, unquestionably, as I have called them, after Mr. Darwin, "the basal wrecks or remnants" of great volcanic mountains, the summits and central parts of which have been blown into the air by continuous explosive outbursts of steam. That they are so is proved by the outward quâquâversal dip of repeated beds of solid lavas and their conglomerates, of which these remnants are always composed. In the moon, on the other hand, as I have already said, there does not exist a single mountain of the kind, and it is not likely, therefore, that its numerous craters ever possessed this character. Our globe, however, presents us with examples of craters of another class, — both large and small, and some of a magnitude almost rivalling in area the largest of the lunar craters,— I mean those craters that have resulted from single eruptions upon fresh points of the earth's surface, and especially the crater-lakes of common occurrence in many volcanic districts—saucer-like hollows surrounded by banks of fragmentary matter, sometimes breached at one or more gaps, which gave issue to a stream of lava that flooded the neighbouring surfaces. There are crater-lakes of this character from 10 to 20 miles in diameter, and each attests the violent outburst of volumes of elastic vapour of enormous amplitude, and a dispersive force equal to scattering to vast distances the materials through which they explode in showers of fragments of lava, scoriæ, and the subjacent rocks, together with mud, sand, or ash mixed with water, when, as seems to have been often the case, the eruption took place beneath a shallow sea or lake. In this last case powerful concentric waves of semi-liquid matter will have been often propelled by each explosion from the centre to the circumference of the basin, where, mixing with the aerial fragmentary showers, they would assist in forming the annular rampart. Now if we suppose explosive eruptions of this character to have burst through the semiliquid and probably molten and incandescent surface of the moon, we have a process capable, I think, of explaining the appearances presented by the lunar craters, not even excepting those of the stupendous areas noticed above as usually called seas.

These vast rings may have been the first effect of the eruptive action on the surface of the moon immediately after its condensation from nebular into liquid matter. It can scarcely be inconceivable that disturbances of that surface may have then occurred on a scale equal to the effect here indicated, when we look to the eruptive phenomena still taking place on the solar disc, of a character not altogether dissimilar, though infinitely more violent, and affecting far larger areas. Even now, on our own planet, oceanic waves, probably occasioned by submarine volcanic eruptions, have at times simultaneously invaded with great violence both the east and west shores of the Pacific, affecting therefore an area equal in diameter to a third of the circumference of the globe.

The process to which I am here attributing the lunar craters may perhaps appear extravagant in respect to the largest of them. But it is difficult to draw a line of separation anywhere between large and small. Nor, I think, ought the element of size to carry much weight in the consideration of the question. It is impossible to assign a limit to the explosive force of expanding vapour or gases at intense temperatures. Incandescent lava drops have been seen, in some eruptions of Iceland, to be thrown up to vertical heights of 20,000 feet and more. The explosions of Tomboro in Sumbawa, and of Coseguina in Central America, have, in recent eruptions, scattered over thousands of square miles around their craters an amount of fragmentary matter sufficient, in either case, to build up an Etna. If we admit that a succession of concentric waves may have propelled the scoriæ congealing on the surface of a boiling sea of lava to unite with those falling after direct ejection from the vent in the formation of an annular rampart around it, we might anticipate the instantaneous solidification of the splashed-up lava there, owing to the absence of any atmosphere to impede the dissipation of its heat into space; and the result might exhibit those precipitous and terraced interior cliffs and the more gradual *exterior slopes* which the larger lunar rings so universally possess. The innumerable smaller craters are undeniably of the ordinary terrestrial type, and from their position may be considered as subsidiary or parasitic to the larger, by which I mean all above three or four miles in diameter. These last, though ranged in strings or clusters, in which each nearly or quite touches another, yet do not cross or (except in the rarest instances) overlap. No more complete proof could be afforded of their simultaneous origin, as well as of their having been mainly produced by that horizontal dispersive force urging concentric waves and jets of matter from the central vent, to which I have ascribed them. Had these several craters been consecutively produced, it is difficult to conceive that the later-formed should not have often covered or overlapped the earlier. So also, if the explosive action had been chiefly vertical rather than horizontal the fragmentary masses thrown up by one vent would often have been mingled with those of its neighbours in irregular ridges, in lieu of the extremely regular rings we see. The next step in the process to the formation of the craters seems to have been, as I have said, the tranquil welling-up from beneath, through their central vents, of a prodigious abundance of liquid lava, filling them up more or less completely, and often causing breaches in the encircling walls, through which floods of lava escaped and spread, either in rugged streams, or more even sheets, over the surrounding plains. This is known to be a very common if not universal circumstance among terrestrial volcanos. And we need not hesitate to believe in its occurrence in those of the moon, because of the vastness of the surfaces apparently covered by its lava-flows. While I am writing I see a report by Professor Leconte describing the great lava-flood of California, Oregon, and Washington, as having, during or after the Miocene period, deluged a tract of between 200,000 and 300,000 square miles, its average thickness being probably 2000 feet! He believes this vast amount of liquid matter "to have been squeezed out from beneath through fissures in the superficial rocks, by horizontal and vertical pressure." The area thus covered exceeds any of the great plains of the moon—even the so-called seas. Subsequently to the occurrence of these lava-floods, their rapidly consolidating surface seems to have been fissured by cracks sometimes radiating from a principal crater like those in starred glass, sometimes independent or irregularly branching from one another; the former appearing to have given vent to partial outflows of lava through their whole length, producing the white streaks already noticed; the latter to some of the small subsidiary cones and craters already alluded to. Vast numbers of these likewise were thrown up on the intervening plains, both within and without the larger crater-rings, and many upon the ramparts themselves. At or about the same time the mountains appear to have risen by exudation as the last product of their central vents. While in some rare cases ranges of similar excrescences (one called the Apennines, of considerable size and height) were produced in the same way from fissures across the plains. Finally, the further consolidation of the surface, together with its shrinkage on contraction, gave rise to the empty cracks already mentioned as here and there traversing the plains.

Such, briefly sketched, is the origin I venture to attribute to the leading features of the moon's visible disc.[1] It does not differ very greatly from the view propounded by MM. Nasmyth and Carpenter, except as maintaining the explosive character of the chief phenomena—bringing them therefore nearer to the analogy of terrestrial vulcanicity. The further progress of consolidation towards the interior seems not to have affected the outer crust, either by that tangential pressure to which some geologists attribute the crumpling of the solidified surface of our globe, or that subsidence of the fractured shell upon a shrinking nucleus, which Mr. Mallet considers to produce, by the conversion of its gravitating force into heat, terrestrial volcanic energy. What contraction may have taken place in the subcortical matter of the moon since the external features I have described were stereotyped on its surface probably satisfied itself by the production of rents, flaws, or cavities in the interior, as often occurs in the cooling of large balls or cylinders of cast iron. It is even possible to imagine that, if any water or atmosphere originally existed upon the moon, it may have been absorbed through the cracks described above into these interior hollows. At all events, no traces appear on the surface of our satellite of further movement or change, whether external or internal, since the incalculably remote epoch when she assumed her present form and features. In this belief we may address her as Byron addressed the ocean—

> Time writes no wrinkles on thy 'silver' brow;
> Such as Creation's dawn beheld, thou rollest now.

G. POULETT SCROPE.

II.—THE PHILOSOPHY OF EVOLUTION.[2]

SINCE 1859, when the Origin of Species appeared, the doctrine of Evolution has permeated into almost every department of human knowledge; changing the ways of thought of the world. Like a clansman's Fiery Cross, it has been passed from Natural History to Physics, from Physics to Morals, to Language, to Intellect, and for some time it has claimed to throw light on the religions of the world, and to be the key to the tangled mysteries of Theology. It is natural, therefore, both that the world should be judged ripe for an essay on the Philosophy of Evolution, and that the author should attempt the more than Herculean task of showing, by help of some department of science, how illustrative it is of the wisdom and beneficence of the Almighty. Of course there are those who think that the attributes of the Infinite are neither amenable to human criticism, or in need of friendly essays "in such departments of science as the Committee of the Royal Institution" think fit, that "its excellence may be known in all the earth." The author is not as one of these. Prizes of a thousand guineas enabled Buckland, Whewell, and the best philosophers of the Bridgwater School, to show with splendid eloquence that the sciences which they adorned were in harmony, not only with the wisdom and beneficence of the Almighty, but also with the revealed doctrine of Creation. Yet such are the laws of supply and demand that now, for exactly one-tenth of the sum which those men received, authors, wanting in neither knowledge nor writing power, come forward to show that not in Creation but in Evolution is the wisdom and goodness of the Creator. We do not quarrel with the later author for his undertaking, for we cannot but rank his work among those minor miracles with which the system of writing for prizes rather than with the selfless enthusiasm of science, may exemplify the processes of man's evolution. Method of treatment may ennoble the most cantankerous subject; but the author's position towards his reader is almost unique. In the preface we learn that "he does not expect to convert any to a belief in Evolution," but only aims at furnishing reasons for accepting that hypothesis to those who, having read Darwin. Spencer, and others, accept the doctrine as established. This description we can only apply to those who gather fashionable beliefs out of circulating libraries, and lack time or ability to possess themselves of an author's arguments. To such readers the book is to be commended, if, indeed, they find they need it; for it contains a good summary of the teachings of "Darwin, Spencer, and others," though even the others are innocent of many of the hypotheses with which the author strives to state the great hypothesis of Evolution, in its bearings on Natural History. The book claims, however, to do this from "the point of view of a physiologist as well as of a naturalist," as though physiology were not the basis of Natural History; but we discover no physiological acumen, or more than ordinary power of suction from the usual sources of information. We are far from denying that the work has merits, and had it been printed with a less exalted title, and free from theological ornament and loose speculation, it might have had claim to the kindly consideration of the general reader; but as the philosophy of Evolution, it fails in never rising to a Kosmic conception of the subject, and therefore *leaves Evolution, not* a philosophy, but an hypothesis.

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[1] A very simple experiment will illustrate to some extent the process to which I ascribe the formation of the lunar craters. If powdered Parian cement or plaster of Paris, mixed with water, of the depth of about half an inch, be placed in a common frying-pan on a hot stove, large bubbles will rise upon its surface, and in a short time several vent-holes will establish themselves, by which the steam generated throughout the mass will escape with some violence; the lateral expansion of the escaping vapour forcing up the half-liquid matter into a circular wall round each vent. Soon the number of vents increases, the whole surface being covered with them. But the first formed are the largest, those later formed diminishing in size, and no two disturbing or interfering with one another. As the plaster dries and hardens, cracks establish themselves. And in the end the crowd of small craters, unequal in size, and not interfering with each other, produces a surface bearing a striking resemblance to portions of the moon's face. If such a surface were supposed to be pressed downwards upon a still liquid substratum, so as to force up some of this through the open vent-holes and cracks, to flood the surface more or less, and consolidate there under the same circumstances as the original matter, the resemblance would be still closer, leading to the belief that the moon's surface owes its characteristic features to some similarly rapid ebullition of a quickly-hardening semi-liquid matter.

[2] The Philosophy of Evolution (an Actonian Prize Essay). By B. THOMPSON LOWNE, M.R.C.S., *F.L.S.* *8vo. pp.* 159. (London: Van Voorst.)

Those who like their science and religion mixed will be grateful for a book in which a little Theology is given, but the mixture is very incomplete, hardly penetrating beyond the opening and the end chapters; and so little is said of the Divine beneficence and wisdom, that no help—new or old—is given to those who endeavour to see it in the fratricidal struggle for existence. To attempt this task and the like, and yet to shrink from grappling with the logical difficulties in the path, will not soothe the troubles which may afflict the mind when matters of belief are mixed indifferently with matters of argument. And although by the terms of the bequest of which this book is a fruit, the task may be attempted only every seven years, we trust that the wisdom and goodness of the Almighty may another time be the pervading theme, or else that science may hold a place that will make it clear that the scientific and theological methods are not one and the same. H. G. S.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—March 25th, 1874.—John Evans, Esq., F.R.S., President, in the Chair. The following communications were read:—

1. "On the Upper Coal-Formation of Eastern Nova Scotia and Prince Edward Island, in its relation to the Permian." By Principal Dawson, LL.D., F.R.S., F.G.S.

The author described the Carboniferous district of Pictou county as showing the whole thickness of the Carboniferous system arranged in three synclinals, the easternmost consisting of the Lower series up to the Middle Coal-formation, and including all the known workable Coal-measures in the district,—the second towards the west of the middle and the lower part of the Upper Coal-formation,—and the third showing in its centre the newest beds of the latter. On the north the bounding anticlinal of the first depression brings up the New-Glasgow Conglomerate, which contains boulders 3 feet in diameter, often belonging to Lower Carboniferous rocks, and represents the upper part of the Millstone-grit or the lower part of the Middle Coal-formation. The author regards this as representing an immense bar or beach, which protected the swamps in which the Pictou main coal was formed.

The succession of the deposits above the Conglomerate was described in some detail as seen in natural sections. The Upper Coal-formation, as shown in the section west of Carribou Harbour, consists of, 1. Red and grey shales, and grey, red, and brown sandstones; and 2. Shales, generally of a deep red colour, alternating with grey, red, and brown sandstones, the red beds becoming more prevalent in the upper part of the section. In Prince Edward Island beds apparently corresponding to these are found, and also gradually become more red in ascending. These are overlain, apparently conformably, by the *Trias.*

The author gave a tabular list of 47 species of plants found in the Upper Coal-formation of Nova Scotia and Prince Edward Island, and stated that all but about ten of these occur also in the Middle Coal-formation. The number of species decreases rapidly towards the upper part of the formation; and this is especially the case in Prince Edward Island, some of the beds in which are considered by the author to be newer than any of those in Nova Scotia. The plants contained in the upper deposits were compared with those of the European Permian, and a correlation was shown to exist between them, so that it becomes a question whether this series was not synchronous with the lower part of the Permian of Europe, although in this district there is no stratigraphical break to establish a boundary between Carboniferous and Permian. The author therefore proposes to name these beds Permo-Carboniferous, and regards them as to some extent bridging over the gap which in Eastern America separates the Carboniferous from the Trias.

DISCUSSION.—Prof. Ramsay agreed with the author in thinking that these Upper Carboniferous rocks represented the Permian, and that there is a gradual passage from the Carboniferous to the Permian. In North Staffordshire there is some evidence of this passage, but not in other parts of England. Mr. Binney had argued that the Permian is the uppermost part of the Carboniferous series; but this is not true in the English area, although it is true if we consider the globe in general. The Coal-measures are grey, black, and blue; but in the upper portion they change to a red tint. During the Coal period we have evidence of estuarine conditions, but subsequently the access of the sea was cut off, and the Permian rocks were formed in vast inland lakes.

Prof. Hughes remarked that the group referred to by Principal Dawson under the head of Permo-Carboniferous could not be considered as in any way proving a passage from Carboniferous to Permian, seeing that the Permian was altogether wanting in Eastern America, unless the fossils approached those of undoubted Permian in Europe. But he pointed out that many large portions of the so-called Permian of Europe had been already proved to be only stained Carboniferous. The fossil lists were founded on a wrong classification of the rocks, which had not yet been set right. Believing, therefore, that the Permian system must be broken up and part given back to the Lower New Red and Magnesian Limestone series, previously so well established, and part to the Upper Carboniferous, he was inclined to refer the Permo-Carboniferous of Principal Dawson to the latter, the difference in the plants being only such as might reasonably be expected between the newer and older portions of a series representing immense lapse of time and changing conditions. Principal Dawson had shown that the beds in question were similar in almost all but colour, and conformable to the underlying undoubted Carboniferous. If, therefore, they were higher than any Carboniferous beds of England, they must be synchronous with the lower part of the unrepresented time between the Carboniferous and so-called Permian; but being more closely connected with the lower rocks, he saw no necessity in the present state of our knowledge for such a term as Permo-Carboniferous.

Prof. Ramsay could not agree with Prof. Hughes in his opinion as to the value of the term Permian. The staining of rocks occurs in two ways, namely, by infiltration from above through overlying beds, and by direct deposition. Silurian rocks are often stained in the former manner.

The President remarked that this paper had given rise to an interesting discussion. The fact of two deposits being conformable in one place and unconformable in another, does not necessarily convert them into one system. He thought there were symptoms that the Permian would eventually be reckoned Upper Carboniferous. He believed that there was a third mode in which rocks were stained, namely, by the oxidation of iron already existing in the beds.

2. "*Note on the* Carboniferous Conglomerates of the Eastern Part

of the Basin of the Eden." By J. G. Goodchild, Esq. Communicated, by permission of the Director-General of the Geological Survey of the United Kingdom, by H. W. Bristow, Esq., F.R.S., F.G.S.

The author commenced by describing in detail the series of beds between the true Basement series of the Carboniferous and the Mountain Limestone as shown in sections at Ash Fell. The general sequence in descending order is as follows:—

a. Carboniferous Limestone, with a few thin beds of stained sandstone and shale; thickness not less than 1000 feet;

b. Obliquely laminated soft, red sandstones, with coal-measure plants, frequently conglomeratic, alternating with fossiliferous shales and beds of limestone; thickness about 500 feet;

c. Limestone, 500 or 600 feet thick, passing down into

d. Shales with thin impure limestones, passing down through calcareous conglomeratic beds into a series of apple-green quartz conglomerates and chocolate and grey shales, succeeded without any clear line of separation by the drift-like red conglomerates, sandstones and shales forming the lower part of the Carboniferous Basement beds, which has been regarded as the equivalent of the Upper Old Red elsewhere.

The author described the mode of occurrence of these deposits in various parts of the district under consideration, and the disturbances which have affected their surface distribution. Along the Cross Fell escarpment a group of sandstones and conglomerates occupies an exceedingly prominent position, especially at and near Roman Fell, whence the author proposes to call these deposits the Roman Fell beds. These beds represent the series *b*, and also the lower part of *a*, at Ash Fell. Following their outcrop towards Cumberland, the conglomeratic beds from the middle downwards increase much in thickness and become much coarser. The author regards the Roman Fell beds as approximately on the horizon of the Calciferous Sandstone series of the south of Scotland, and he remarks that they are locally undistinguishable from much of the Basement series, and have been described by authors as undoubted Old Red Sandstone.

Discussion.—Prof. Hughes confirmed the observations of Mr. Goodchild, and showed their importance as bearing upon inquiries into the changes of the land which furnished, and of the currents which arranged the materials of the beds described.

Prof. Ramsay remarked that the author was entitled to much praise for the manner in which he had worked out the minor details of the Carboniferous system. The Cross Fell had been called Old Red Sandstone; it is now placed in the Lower Carboniferous, but no distinct line of demarcation can be determined. Prof. Ramsay remarked on the distribution of deposits of the Carboniferous series in Britain, and referred especially to the Carboniferous limestone. In the south of Pembroke and Glamorganshire this formation is 2500 or 3000 feet thick; in the Devonshire area 100 feet, and in the north of Glamorganshire 500–600 feet represent the whole of the Mountain Limestone; in Coalbrook Dale, again, its thickness is only about 100 feet, in North Wales 800 feet, in Anglesea 500 feet. In advancing towards Palæozoic districts, where old land existed, the limestone becomes thin, whilst it becomes thick in the deep water areas,—in Derbyshire 3000–4000 feet, falling off to less than 1000 feet in Cumberland, where it is split up by sandstones; and this is still more strikingly the case in Scotland, where 100 feet of limestone is a rarity. He thought the existence *of Coral Reefs in the Mountain* Limestone doubtful.

Mr. Tiddeman remarked that the Mountain Limestone was 3000 or 4000 feet thick in the Lake-district, and in the Pennine Chain, at a distance of 15 miles, only 600 ft.

3. "An Account of a Well-section in the Chalk at the North End of Driffield, East Yorkshire," By R. Mortimer, Esq. Communicated by W. Whitaker, Esq., F.G.S.

In this paper, which was in continuation of a former communication to the Society (Q. J. G. S. vol. xxix. p. 417), the author stated that the well-section referred to passed through 7 feet of clay and 47 feet of chalk, the upper 3 or 4 feet of the latter very rubbly and broken. The chalk was bedded in laminæ of from $\frac{1}{16}$ in. to 16 in. thick. From a depth of 20 feet downwards the well exposed many nearly vertical partings running in all directions through the Chalk, and the surfaces of the blocks thus marked out showed numerous striæ, such as were described in the author's former paper. These striæ were in most cases horizontal, but some surfaces showed them at an angle of 45° to the horizon. The laminæ of which the chalk was composed were separated by layers of a softer substance like Fuller's earth, containing 1·67 per cent. of organic matter, 7·05 per cent. of oxide of iron, 10·23 per cent. of alumina, and 34·80 per cent. of silica. The author regards this soft substance as formed by the disintegration of chalk, shells, etc., caused probably by the periodical prevalence of great waves or other disturbances in the Cretaceous sea. The effect of its formation he considers would be to check the upward growth of the mass of chalk, which he now, as formerly, ascribes to the direct secreting action of numerous zoophytes. In support of this view he states that the surfaces of the chalk laminæ are more or less irregular, and not even as if produced by quiet sedimentary deposition. The paper contained detailed analyses of the chalk and of the soft partings.

Discussion.—Prof. Hughes thought that the origin of the particular structure referred to by Mr. Mortimer was a question for mineralogists and chemists, though somewhat similar forms might be produced mechanically. He pointed out that its occasional occurrence along fissures not in the line of bedding was quite conclusive against its being in any way referable to the period of original deposition. As to the more clayey bands, he considered the Chalk, though often composed in a great measure of comminuted organisms, to be all sedimentary, and had therefore no difficulty in explaining how more clayey matter might accumulate over various areas at different times.

Mr. Wiltshire mentioned that argillaceous bands extending over wide areas are to be observed in the Chalk.

Mr. Whitaker stated that clay bands occur near Beachy Head. He considered that the argillaceous bands are not seen in hard chalk. The analyses given by the author were of much value.

Mr. Charlesworth remarked that the Yorkshire Chalk presents exceptional characters. The sponges found fossilized in it are silicified throughout, but the silica is confined to the sponges, and does not invest them.

Mr. Koch stated that near Nice the Dolomitic Limestone sometimes exhibits a structure similar to that described in the paper, and that when this structure occurs, minute crystals can be detected in the mass.

4. "On Slickensides or Rock-striations, particularly those of the Chalk." By Dr. Ogier Ward. Communicated by Prof. Morris, F.G.S.

The author referred to previous communications on this subject, and maintained that the striæ observed in chalk are to be regarded as slickensides caused by disturbance and movement of the rock. He described the appearances in detail, and mentioned the occurrence of similar striations in various rocks.

Discussion.—Mr. Whitaker said that some of the specimens on the table sent by Dr. Ward showed slickensides, but that in certain cases the fibrous structure runs through the whole substance.

Mr. W. T. Blanford stated that he had seen a similar structure in an undisturbed white clay resembling pipeclay, so that he thought the appearance could not be produced by motion.

The President remarked that the structures brought forward appeared to be of two kinds: first, slickensides pure and simple; and secondly, fibrous structure, the latter probably due to chemical action, either by an incipient formation of aragonite, or by the formation of that mineral and its subsequent partial decomposition.

CORRESPONDENCE.

ON THE CHESIL BANK.

Sir,—I am glad of the opportunity, given by Mr. Kinahan's question, to explain what I mean by a "drowned valley." I apply this term to an inlet of the sea, which occupies a valley originally subaerial, and excavated by subaerial causes, but into which the sea has subsequently run, owing either to a subsidence of the land, or, if such a thing be admitted as possible, by a raising of the level of the ocean at the locality. There are many causes which, to my mind, seem to point to the latter as having really happened.

In many parts of the English coast old cliffs may often be traced where high ground meets alluvial tracts of salt marsh. I believe them to have been formed during the period of the formation of the Scrobicularia Clays which overlie the submerged forests. These cliffs do not indicate the mode of *formation* of the bays, which have since become alluvial tracts, but are merely traces of their slight enlargement after the sea had gained access to their areas.

The order of events has been:—1. Excavation of the valleys by subaerial causes. 2. Growth of forests now submerged. 3. Depression; and formation of Scrobicularia Clays and low cliffs—probably the period of the 30 feet raised beaches. 4. Slight re-elevation, and silting up of some of the estuaries (not of all), bringing them into their present condition.

The reason why I affirm that there were never marginal cliffs to the Fleet is, because I have seen no vestiges of them. The gently undulating surface of the ground declines gradually to the water's edge; and I have collected fossils from the outcrop of the beds at the edge of the Fleet, where, if there had been formerly cliffs, we ought now to find tumbled talus. Mrs. Bristow's characteristic sketch, in Vol. VI. of the Magazine, gives an exceedingly good idea of the ground, it being premised that all shown is upland. There is no alluvial ground shown in it. The only alluvial tract is a small part at the extreme head of the estuary, which in the sketch is hidden by a projecting mound. Referring to the questions opened by Colonel

Greenwood and Mr. Kinahan with regard to the transportation of the pebbles which form this beach: Colonel Greenwood, if I understand him rightly, considers the pebbles to travel along the beach, being moved onwards by waves under the influence of the wind, and consequently on the average travelling in the direction of the prevailing wind. I have, I am afraid to say how long ago, noticed this action on the Chesil Beach. I have seen the waves rolling in from the Atlantic (for we are not here in the presence of narrow seas, as Mr. Kinahan appears to think) take up the pebbles from one spot, and dash them down again some little distance to the leeward. They no doubt travel along the Beach under this action. But does it follow that that is how they came there? I say, no. If it were, how could the larger stones be at the end most distant from the main land?

Some of the most violent storms on this coast come somewhat from the south of south-west, so that their action is, I suspect, rather to carry the pebbles by wave-action towards the north-west end of the Beach, and probably their attrition, as they move onwards, partly accounts for their gradual decrease in size as we follow them in that direction.

Among the pebbles are a few, chiefly at the southern end, from Portland; but the larger proportion consists of Chert from the Upper Greensand of the west of Dorset and of Devon, and of other pebbles, which appear to be derived from the Trias of the same district. This shows that they have come across the west bay. Sir Charles Lyell explains the case thus:[1] "The force of the sea increases southwards, and as the direction of the bank is from north-west to south-east, the size of the masses coming from the westward, and thrown ashore, must always be largest where the motion of the waves and currents is most violent." It seems then that the currents must store up an accumulation of pebbles beneath the bay, within reach of the shore, which, on occasions of unusual wave-action, are cast up in masses upon the beach.

O. Fisher.

WHY ARE THE LARGEST STONES FOUND AT THE EAST END OF THE CHESIL BANK?

Sir,—It has puzzled many observers to find that, contrary to expectation, the largest shingle is at the east end of the Chesil Bank, though it is well ascertained that the whole mass of pebbles have travelled from the westward—the usual inference being that the further the pebbles have travelled the smaller they become.

As bearing on the mechanical problems involved in this striking phenomenon of nature—which, seen in its whole extent from an elevation, resembles nothing so much as a large railway embankment—the fact is extremely interesting, and admits to my mind of a very simple explanation; for the individual stones merely follow the law applying to the whole bank, which increases in height and sectional area as is it approaches Portland. It is evident that the force of the insetting tidal current, assisted by the prevailing wind, must increase in angular intensity as it approaches and is deflected from the hollow of the bend of the bank produced by the promontory of Portland. At this point also will the wind waves have the greatest power. It is also easy to understand that the amount of material cast up above high water will vary as the energy of wave action varies, and consequently the largest stones will be thrown up at the point of intensest action. As the shingle of all sizes travels eastward along the beach the smaller stones are cast up first, the larger ones being weightier have less lateral upshore movement, and so travel further. In fact I conceive the phenomenon must necessarily follow from the application of the known mechanical law of the inclined plane—the greater weights travelling up a more extended and therefore lesser gradient, until they come within the range of waves sufficiently powerful to cast them upon the bank itself.

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[1] Principles, vol. i. p. 539. 1872.

It is quite clear to me that the whole bank is the result of causes now at work, and which have continued with remarkable uniformity since the last relative change of level of land and sea. With Mr. Fisher I agree that the irregular shingle-banks and inclosed lagoons on the coast of Ireland, mentioned by Mr. Kinahan, are not at all parallel phenomena.

HEATH HOUSE, BLUNDELLSANDS, T. MELLARD READE, C.E.
LIVERPOOL, *April 7th*, 1874.

HYBODUS, A COAL-MEASURE FISH.

SIR,—While examining a work by Pictet this morning, entitled "Traité de Paléontologie," I stumbled upon the following remarks in the second volume, p. 256; he is speaking of *Hybodus:* "Beaucoup d'autres sont connues seulement par leurs dents. Deux espèces sont citées dans les terrains carbonifères. Ce sont les *Hybodus carbonarius* et *vicinalis*, Giebel de Wettin."

His authority for this statement is Giebel, in his work on the "Fauna der Vorwelt." I was much surprised, and yet gratified, to find that my opinion of *Hybodus* being a Coal-measure Fish, arrived at quite independently, should be corroborated by so eminent a palæontologist. Of course my statement that *Hybodus* had never been described previously to my paper as a Coal-measure Fish is erroneous; but considering that Agassiz, Owen, Huxley, Pander, Munster, M'Coy, Newberry, etc., etc., do not refer to the work, nor to the fact in any way, I consider myself quite justified in making it. However, Giebel and I have arrived, quite independently, at the conclusion that the teeth of *Hybodus* are to be obtained in the Coal-measures, and we coincided so far that, in a list of Palæozoic Fishes I am preparing, I had actually named our English Coal-measure *Hybodus*, *H. carbonarius*. This name, however, I must withdraw, if my species does not resemble his; but, unfortunately, I have not any means of comparing their characteristics: for Giebel's work is not among the geological books I have access to; so the specific name of the *Hybodus* from our Carboniferous formations must for the present be in abeyance.

NEWCASTLE-ON-TYNE,
April 24th, 1874.

W. J. BARKAS, L.R.C.P.L.

MAGISTER SCHMIDT ON THE SHIELDS OF *PTERASPIS* AND *SCAPHASPIS*.[1]

SIR,—I have just received, by the kindness of Herr Magister Schmidt, a paper by him entitled, "On Pteraspids in general, and on *Pteraspis Knerii* in particular," which, I dare say, may come to the notice of some of your readers. Herr Schmidt reiterates the view which I have previously discussed as to the nature of the shields for which I proposed the genus *Scaphaspis*. Let me again say here that *no evidence whatever* is adduced by Herr Schmidt in support of the notion that *Scaphaspis* is the ventral shield of *Pteraspis* and *Cyathaspis*. That such a connexion is a possibility, I do not mean to deny; but with a very much larger number of specimens to study than Schmidt or Kunth have had, and with the same hypothesis present in my mind, I have been unable to find justification for its adoption.

With regard to the Galician *Pteraspis*, I have already stated in the GEOLOGICAL MAGAZINE,[2] after examining specimens from this locality in Vienna, I was led to doubt the specific distinctness of the *Pt. Knerii*. The Viennese specimens come very close indeed to *Pteraspis rostratus* and *Scaphaspis Lloydii*. The specimen of a disc now figured by Schmidt comes so close to that of *Pt. Crouchii* that it must probably be assigned to that species. Magister Schmidt is mistaken in assuming an *exclusive* association of *Pt. rostratus* with *Sc. rectus*. On this matter I should be glad if some of my friends at Ludlow and elsewhere in the Cornstone area would give their experience.

The asserted presence of bone-lacunæ in the Heterostraci certainly cannot be accepted on such evidence as that which Herr Schmidt adduces. Either his sections do not show definite bone-lacunæ or they have been very inadequately lithographed.

NAPLES, *April 25th*.

E. RAY LANKESTER.

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[1] For Magister Schmidt's letters see GEOL. MAG. 1873, Vol. X. pp. 152 and 330.
[2] For Mr. Lankester's reply see *op. cit.* Vol. X. pp. 190 and 478.

COMMUNICATIONS HAVE BEEN RECEIVED FROM:—

Miss Alder, Messrs. J. Milne, W. J. Henwood, H. P. Malet, Robert Mallet, W. H. Hudlestone, J. Wetherell, G. A. Lebour, E. B. Tawney, Dr. Barkas, Chas. W. Peach, Dr. O. G. Ward, A. H. Swinton, James Thomson, A. Gillett, J. W. Judd, Henry Johnson.

TO CORRESPONDENTS.—It is particularly requested that all Communications intended for this Magazine may be addressed to the Editor, 142, St. Paul's Road, Camden Square, N.W. Books and Specimens may be addressed to the Editor, *care of* Messrs. Trübner & Co., 57 and 59, Ludgate Hill, E.C.

THE
GEOLOGICAL MAGAZINE.
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No. VII.—JULY, 1874.

ORIGINAL ARTICLES.

I.—ON THE DAWN AND DEVELOPMENT OF LIFE ON THE EARTH.[1]

By HENRY WOODWARD, F.R.S., F.G.S., of the British Museum.

IN 'The East,' that wonderful cradle of the human race, towards whose sunrise we turn to find the dawn at once of Civilization and Romance, Nature exhibits herself in all the exuberance of her vitality, both of plant and animal. The summer and the rainy season unite, with no intervening period of spring and autumn. Seasons, like days, spring suddenly into full-blown development. Night is succeeded by day without dawn, and day by night without the lingering hues of eve.

What wonder, then, that our ideas of Creation, derived as they undoubtedly were from Oriental tradition, should take the form of the opening of subtropical life rather than of our more graduated temperate zone; or that we should read of man and all animate creation springing suddenly into being from the rainy waste of chaos, each and all fully developed, as we behold them to-day!

"Nothing was in being," say the old men of an Indian tribe. "All was null and void; there was no sky, no earth, no sea, no shore; suddenly seven warriors found themselves seated on the edge of a lake, smoking the calumet of peace, and their wives were already working in the wigwams."

No legend can more vividly bring before us the notion that man has passed his infancy as if in a dream.

If for a moment we recall our own early recollections, we shall generally find they carry us back to some event, or place, or person, which filled our dawning intelligence, to the exclusion of all else, and beyond which we are unable to peer through the mist.

Turning from the consideration of our own impressions,—which, after the minutest self-investigation, would, unassisted by the guidance of friends older than ourselves, simply land us at the same conclusion arrived at by Topsy—"spect I growed,"—let us learn how far History traces back the ancestry of our race and the changes of the world we dwell in. Alas! written documents do not carry us back more than thirty or forty centuries, whilst the most ancient remains of edifices, built at any previous epoch, which also may be called "*archives of stone*," date back perhaps 2000 years earlier;

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[1] Being the substance of a lecture delivered before the Bradford Philosophical Society, March 5th, 1873, and *elsewhere*.

but far beyond this short historic period, which scarcely comprises the lapse of one hundred and fifty generations, extends a space of time, certainly far longer, known to us only by pure tradition. Mankind, already arising from its infancy to a more enlarged self-consciousness, had begun to link age to age by legends, poems, and symbolic formula. The reminiscences of great events, migrations, wars of races, alliances, exterminations, and triumphs of industry, were incorporated into religion itself, and in an increasingly varied form were handed down from age to age as the heritage of nations.[1]

In still more ancient times, in the dim mist of bygone ages, our ancestors lived the life of wild beasts in forests and caves.

Tradition, no less than history, is dumb as to this epoch of the human race; but by the labours of the geologist, we are beginning to learn somewhat concerning the habits and customs of these earliest ancestors of ours so long unknown to us.

If then History and Tradition cannot relate these earlier chapters in the infancy of mankind, but, like the efforts to recall the events of our childhood, are arrested by want of memory from telling us more, how powerless are they to inform us of those long lapses of ages when the lower animals already peopled this earth of ours—animals whose life-history probably extended over tens of thousands of generations before Man, the proud ruler of the Earth, appeared upon the scene of his conquests!

How then can we ever hope successfully to trace the dawn of life upwards to its source through that long vista of ages comprised in the life of our planet, in comparison to which man's whole existence is but as a thing of yesterday? Truly the accomplishment of such a task seems at first sight far more remote in prospect than the discovery of the sources of the Nile.

What records can we search? What monuments explore? Has earth no sepulchre for the mighty save those erected by man to commemorate his short-lived fellows? Not so; every quarry by the road-side, every chalk-pit and brick-field are but so many mausolea, in which repose the hosts of living beings which peopled earth, air, or sea, in the old time, and, like the piled-up coffins in some ancient cemetery, they rise one upon another until they culminate in the snow-capped peaks of the Himalayas and the Andes, beside which the proud pyramid of Cheops seems but as a mole-hill.

Let us pry into this mighty charnel-house of Earth's great family, and strive, by the light which science lends us, to decipher some of the hieroglyphics, which tell to those who can read them aright the life-history of our globe. And here a wonderful historical parallelism presents itself to our minds between the early records of mankind and those of the earth's life-history; for just as the comparative labour of the palæographer increases the farther he carries his researches back into the remote past, encountering in turn Roman, Greek, Etruscan, Phœnician, Egyptian, and Assyrian characters, so in like manner the palæontologist passes gradually from the consideration of forms differing but little, if at all, from those living around him to-day, until he finds himself surrounded by a fauna and a flora, which, though broadly related to our own, yet differs so much in every detail that he fails at once to perceive that it has anything in common with that now existing. Yet comparative anatomy and comparative botany teach us that all the types of past life—like the early alphabets and symbols invented by mankind—can be brought into accord and correlated with existing types, and that in each case one system of classification is capable of embracing the whole.

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[1] *Reclus: English* edition, edited by H. Woodward. "The Ocean, Atmosphere, and *Life," Section II. page* 190.

In order rightly to understand the records of Earth's monuments, we must, in the first place, call in the geologist to explain to us such physical facts as are needful for us to become acquainted with before attempting to read its organic remains aright, each one of which may be looked upon as a hieroglyphic symbol which the palæontologist aims at deciphering.

From the geologist we learn that the great storehouses wherein the life-relics of the earth's past inhabitants lie embalmed are the sedimentary rocks. He tells us that these have resulted from the wear and tear carried on by meteoric agents of all those portions of the earth's surface elevated above the general ocean of the globe. We thus learn, that *from the very beginning* of life on the earth there must have been areas of depression and areas of elevation on our planet; the former occupied by the waters of the ocean, and the latter forming continents and islands exposed to all the influences of sun and wind, frost, snow and ice, rain and rivers, without which no sedimentary deposits could have been formed. We learn, moreover, from an inspection of the organic remains themselves, preserved in the various rocks, that there were in former ages terrestrial plants and animals as well as fresh-water and marine forms of life, although the evidences of the last-named types are by far the most abundant.

Thus in the ancient submerged Forest-bed on the Norfolk Coast, in the Brick-earths of Ilford and Grays, in the Valley of the Thames, and in the London Clay, we have abundant evidence of old land conditions, the first being preserved as a land-deposit, the second as a fluviatile one "*almost in situ*," the last named being an estuarine or *near-shore* deposit, formed at the embouchure of some large river, probably flowing, as the Nile does at the present day, from near the Equator in a north-easterly direction, watering a continent once occupying a part at least of the present site of the Atlantic, and perhaps embracing within its extent the Cape de Verdes, the Canaries and Azores, all of which are volcanic, and mark an area of disturbance and oscillation of level which may have been more than once elevated and again submerged in very modern times.

But although, as already stated, these later sedimentary deposits afford remains of animals and plants, which, with few exceptions, differ but little from those of the present day, yet it must be borne in mind that their geographical distribution has been greatly modified. For instance, referring back to the Norfolk Forest-bed and *the Brick-earth of the* Thames Valley, we find abundant evidence in the remains of *Elephants*, *Rhinoceroses*, *Hippopotami*, &c., that the Eastern Counties were stocked with herds of quite another order from those which now occupy our pastures.

Again, in the Suffolk and Antwerp Crag are preserved immense stores of the bones of Whales and other Cetaceans, also remains of the huge Dinotherium, with Tapirs and other land quadrupeds; whilst in the London Clay we have relics of abundant subtropical vegetation, evidenced by Palm-wood and fruits, with remains of numerous extinct genera of animals, such as the *Palæotherium*, *Anoplotherium*, and *Xiphodon*, allied to the Tapir, Horse, Hyrax, &c., with many birds, including a large Struthious bird of the size of the living Ostrich (*Dasornis Londiniensis*), and an aquatic bird with dentigerous mandibles, the *Odontopteryx toliapicus*; whilst the shores of the estuary and sea into which these remains of terrestrial life were carried was the home of *Crocodilia*, *Cheloniæ*, and Sharks; with a Molluscan Fauna rich in *Volutes* and other sea-snails, and teeming with *Nautili*, Squids, and Cuttle-fishes, like the warmer subtropical seas of the present day.

We have in the Eocene series in this country only a trace of the great Nummulitic formation which plays a far more conspicuous part than any other Tertiary rock in the solid framework of the earth's crust. On the Continent it becomes a great limestone formation, and attains a thickness of many thousand feet, rising in the Swiss Alps to a height of 10,000 feet above the sea. It occurs also in the Pyrenees, and extends from the Alps to the Carpathians, and is in full force in the North of Africa, as, for example, in Algeria and Morocco. In Egypt, the quarries in this rock near Cairo furnished the Pharoahs with building-stone for the Pyramids.[1] It extends into Asia, and across Persia, by Bagdad, to the mouths of the Indus. It occurs in Cutch, and in the mountain ranges which separate Scinde from Persia,[2] and forms the passes leading to Caboul. In Thibet it has been found at an elevation of 16,500 feet above the sea, and it has been followed as far as Eastern Bengal and the frontiers of China.

These vast masses of strata have resulted almost wholly from the accumulation of the shells of Foraminifera, one of the lowest forms of animal life belonging to the PROTOZOA, and to the same class as the *Eozoon Canadense*, to be alluded to presently.

Beneath these Tertiary beds, which partake most largely of the forms of life we see around us to-day, we come upon a series of strata known as the Cretaceous series, the thickest bed of which is the Chalk, which at some places attains a depth of more than a thousand feet, and covers an area as great as that of Europe.[3]

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[1] Herodotus mistook the Nummulites in the limestone of the Pyramids for Beans. See also Exodus v. 12.

[2] A gigantic oval Nummulite (as large as a hen's egg), named *Loftusia Persica* by Messrs. Carpenter and Brady, was obtained in abundance by W. K. Loftus, Esq., in 1849-52 (during the progress of the commission appointed to demark the Turko-*Persian* Frontier), at Kellapstun Pass near Dú Púlun Bakhtiyari Mountains, Persia. —*Phil. Trans.* 1869, p. 739, pl. 77-80.

[3] In the youngest bed, the Maestricht-chalk, we find the Mosasaurus, a great lizard,

From certain prevalent organisms found in it, such as shells of *Oysters*, *Ammonites*, *Nautili*, *Starfishes*, and *Echinoderms*, bones and teeth of fishes, geologists rightly conclude it to be a truly marine deposit.

But of what is the great bulk composed? Is it merely a finely comminuted white mud?—for such it seems to be to the unassisted eye. No; when washed and examined beneath the microscope, we find it to consist almost wholly of two distinct minute organisms.

The general mass of it is made up of very minute granules; but imbedded in this matrix are innumerable bodies, some smaller, some larger, but on a rough average not more than a hundredth of an inch in diameter, having a well-defined shape and structure. A cubic inch of some specimens of chalk may contain hundreds of thousands of these bodies, compacted together with incalculable millions of the granules.

The larger bodies when separated prove to be each one a beautifully constructed calcareous fabric made up of a number of chambers, communicating freely with one another. The commonest of these is called *Globigerina*, and sometimes seems to compose nearly the entire mass of the chalk.

In the soundings carried out by Captain Dayman, R.N., in connexion with the laying of the submarine cable between Ireland and Newfoundland, it was ascertained that almost the whole floor of the great central plain of the Atlantic, more than 1000 miles across from east to west, and which extends for many hundred miles in a north and south direction, is covered (at a depth of 1700 fathoms) by fine mud, which, when brought to the surface, dries into a greyish-white friable substance resembling soft grey chalk. When examined under the microscope, it proves to be composed of innumerable *Globigerinæ* (together with Diatoms) imbedded in a granular matrix.

Thus, then, this deep-sea mud is substantially like the Chalk. Prof. Huxley (upon whom the task devolved of examining these deep-sea soundings) was surprised to find the "granules" of the mud in which the *Globigerinæ* abound had a definite form and size. He named these bodies *coccoliths*, but doubted their organic origin. Dr. Wallich, who accompanied Sir Leopold M'Clintock, in 1860, in the cruise of H.M.S. "Bull-dog," verified these observations of Huxley's, and added the interesting discovery that not unfrequently bodies similar to these *coccoliths* were aggregated together into spheroids, which he termed *coccospheres*.

Mr. H. C. Sorby, F.R.S., in making a careful microscopic examination of the chalk, observed, as Ehrenberg had done before him, that much of its granular basis possesses a definite form. Comparing these formed particles with those in the Atlantic soundings, he found the two to be identical; and thus proved that the chalk, like the soundings, contains these mysterious *coccoliths* and *coccospheres*, as well as the shells of *Globigerinæ*. Professor Huxley has since traced out the development of the "*coccoliths*" from a diameter of

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with formidable jaws, which once inhabited the valley of the Meuse. The Leiodon, *Owen, from the Upper Chalk near* Norwich, is closely allied to the Mosasaurus.

$\frac{1}{7000}$ of an inch up to their largest size, which is about $\frac{1}{1000}$, and no longer doubts that they are produced by independent organisms, which, like the *Globigerinæ*, live and die at the bottom of the sea, at a depth of two miles beneath the surface.

There seems then to be good ground for the conclusion that the chalk itself is the dried mud of an ancient deep sea, and, like the present ooze of the Atlantic, has been slowly accumulated in the abysses of the ocean. We thus see that the Chalk and the Nummulitic Limestone are both largely formed of the dead shells of Foraminifera accumulated in deep and wide oceans, which once and again occupied the site of the present old world continent.

But the Chalk furnishes remains of many organisms besides Foraminifera. It has afforded relics of some of the largest of those remarkable flying lizards, the *Pterodactyles*, at present met with; whilst the lower beds have also yielded one of the latest forms of land lizards.[1]

Thus we have already extended our researches back sufficiently far to have met with *three extinct orders*,—the *Pterosauria*, the *Plesiosauria*, and the *Dinosauria*,—which are only known to us in a fossil state.

The succeeding Greensand, Neocomian, Wealden, and Purbeck series yield us many more types of these extinct fossil Reptilian forms, and exemplify in a remarkable degree the changes in climate, and consequently in. geographical distribution, which must have taken place to enable such animals to flourish in this country.

The rare shells of *Pleurotomaria*,[2] as also *Brachiopoda*, were exceedingly well represented in the Oolitic and Cretaceous rocks. Nor do we find many new orders in the Oolitic series with which we are not already made acquainted in the more modern Cretaceous and Tertiary formations. The most interesting form is that of the *Archæopteryx*, a bird with a remarkably un-avian development of its caudal vertebræ, and possessing free wing-digits armed with claws. The head of this bird is wanting, but from the more recent discoveries of remains of extinct birds by Prof. O. C. Marsh, in the Cretaceous beds of Kansas, we may reasonably presume that these earlier birds probably possessed mandibles armed with teeth.[3]

The short-necked and massive *Pliosaurus*, which occurs both in the Portland stone and the Kimmeridge Clay, affords us another type of those ancient and extinct sea-lizards once so numerous in the seas of the Mesozoic epoch; whilst the remains of the great *Cetiosaurus* and *Megalosaurus* testify to the magnitude of the land-reptiles of these Secondary rocks.

But whilst the Reptilia during the Mesozoic or Secondary Period increased enormously on the face of the earth, and in the waters, both in size and numbers, so as to have caused this period to be called "the age of Reptiles," the *Mammalia* were *apparently* reduced to a few minute forms of Insectivorous Marsupials, known to us only from a rare series of their lower jaws, discovered in the Purbeck beds and Stonesfield slates, the largest of which was no bigger than the living Opossum.[1] Yet in speaking of the huge Reptiles of the Old World, of whose colossal size we gather a notion from the cases containing their bones in the British Museum, and from the plaster restorations in the grounds of the Crystal Palace at Sydenham, how apt we are to overlook the fact that *the largest animals of the present day far exceed in size those of any previous epoch!* Where shall we find a fossil lizard, whether of the land or sea, to vie with the great "Finner whale" of our own day? —hugest of beasts that live, or ever have lived, disporting his eighty or ninety feet of bone, muscle, and blubber, with easy roll among the waves, secure from shipwreck in the stormiest sea.

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[1] *Acanthopholis*, Huxley.

[2] *One* living example has been obtained from the West Indies, and was valued by M. Damon at *50l.* 400 species are known in a fossil state extending from the Lower Silurian to the Chalk.

[3] *Prof. Marsh* has discovered two—*Ichthyornis dispar*, Marsh, and *Apatornis celer*, *Marsh, both from Kansas*, U.S.

The great class of Mammalia then to which we belong not only includes all the higher orders existing at the present day, but also the *largest living beings*, for the huge fish-like Cetacea are true warm-blooded air-breathers like ourselves, and are as assiduous in the care of their young as is the tenderest human mother.

In the Lias we meet with another type of extinct sea-lizard, the *Ichthyosaurus*, the remains of which have been largely preserved in England, especially at Lyme Regis, at Street, at Barrow-on-Soar, and at Whitby.

This is the most fish-like of the lizards of the Mesozoic period, and must have been a veritable shark amidst the smaller fry, to judge by his terrible jaws armed with hundreds of conical teeth. Indeed, the contents of his stomach betray even a cannibal tendency, for when an hungered, he seems occasionally to have stayed his appetite till dinner-time with three or four baby Ichthyosaurs *au naturel!*

The great feature of the Mesozoic age was no doubt its *Ammonites*; but besides these it had a rich assemblage of *Trigoniæ*, a shell now only found living on the coasts of Australia, of *Terebratulæ* and *Rhynchonellæ*, of *Cidaridæ*, and of that beautiful form of Crinoid "the Bradford Pear-encrinite" *Apiocrinites Parkinsoni*; and, lastly, of King-crabs and other Crustacea, with Dragon-flies and Cycadaceous plants. In the Vertebrate classes it had its Chimæroid Sharks, with palatal crushing teeth; its Pycnodont fishes; its *Ichthyosauria*, *Plesiosauria*, *Pterosauria*, and *Dinosauria*; its long-tailed birds; its all but oldest Mammals yet discovered.

From this wonderful and rich display of life-forms we next pass over a long series of dreary almost unfossiliferous red sands and marls charged with gypsum and rock-salt, chiefly remarkable for the scanty evidences of another lost Reptilian order (the *Labyrinthodon*), helped out by abundance of foot-tracks of quadrupedal and bipedal Reptiles, and some perhaps of Birds (?). Some *exceedingly minute teeth* have also been obtained near Stuttgart, which are considered by

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[1] See Prof. Owen's Monograph on the Mesozoic Mammalia, Pal. Soc. 1871, vol. *xxiv. pl. i.–iv.*

Prof. Pleininger to be those of a *very small* Mammal, called *Microlestes antiquus*, believed to have been a minute plant-eating marsupial.

In the Muschelkalk a curious fossil, determined by Prof. Owen to be a *Saurian*, and named *Placodus* (originally referred by Münster and Agassiz to the class of Fishes), has been met with, which had palatal teeth, and fed no doubt on shell-bearing Mollusca, for crushing which its broad flat teeth seem well adapted.

This Muschelkalk also yields a beautiful form of stone-lily (*Encrinus liliiformis*), also another genus of *Cephalopods* allied to the Ammonites, named *Ceratites*.

Here geologists draw the line between Palæozoic and Neozoic.

The latest Palæozoic formation is the *Permian*, a series of rocks not rich in fossils, but marked in this country by limestones rich in magnesia, often forming concretionary masses termed "botryoidal," and largely developed in Carinthia, where these Dolomite limestones form vast isolated pillar-like mountains, which have been compared to ancient coral reefs dolomitized and changed to stone, and lifted high and dry out of the sea, like some big wreck cast ashore, to tell of their former submergence.

These Permian-beds are also largely Copper-bearing in Germany, particularly in Thuringia. *Productus horridus, Spirifer undulatus*, and a few more shells, with branches of a Coniferous tree, together with certain fishes, such as *Platysomus* and *Palæoniscus*, mark these beds.

Leaving, however, these comparatively barren rocks, we next come, in descending order, upon what must ever be looked upon as the most wonderful assemblage of fossil organisms in the entire stratified series—the Carboniferous formation, with its Coal-measures, which attain, in the South-Wales Coal-field, an aggregate thickness of 12,000 feet, and comprise 100 seams of coal. Every one of these seams has its roof-shale and its under-clay. The roof-shale marks a break in the conditions of vegetable growth, decay, and accumulation caused by an inundation of foreign matter, probably introduced by a local subsidence of the area, to be again re-elevated, and again covered by a new forest of Carboniferous trees.

Every under-clay is full of *Stigmariæ*, the roots of the larger trees which contributed by their growth and decay to form the Coal.

What were the trees of the Forests of the Coal-period? Were they Oaks? or Beeches? or Pines? or Gum-trees? or Palms? No, none of these, but, strange as it may seem, humble Cryptogams were in this far-off period the precursors of the Sequoia and the Oak; the little Liverwort and humble Club-moss are the modern representatives of the *Lepidodendron* and the *Sigillaria*; whilst the common Mare's-tail or *Equisetum* of our ditches was then a giant Calamite, associated with vast numbers of ferns, some of which were arborescent in habit.

In its stagnant or slowly moving streams the *Archægosaurus* and *Anthracosaurus*, another type of Labyrinthodont reptile, moved, with *Baphetes, Pholidogaster*, and some thirty others of its kindred, whilst *Hylonomus*, probably an insectivorous reptile, may have [illegible]scended the trunks of the aged trees in search of Insects, of which *veral have* been discovered in the Coal.

Nor must we omit that besides a Chilognathous Myriapod (*Xylobius sigillariæ*), Dr. Dawson's labours have brought to light two air-breathing Snails, *Pupa vetusta* and *Conulus priscus.*

Among the fossils *foreign to the Coal itself*, yet found associated with it in the Clay-ironstone nodules of the Coal-measures, have been discovered numerous small *King-Crabs*, a beautiful wing of a large Locust, *Gryllacris lithanthraca,* and an entire Arachnide from the Dudley Coal-field, *Eophrynus Prestvicii*, two *Scorpions* and a Spider from the Coal of Silesia, the *Protolycosa anthracophila.*

The Forest Marble of Wiltshire has the honour of furnishing the earliest-known short-tailed Crab (the *Palæinachus longipes*), whilst the Coal presents us with the earliest-known Lobster (the *Anthrapalæmon Grossartii*). Another form of Nautiloid shell is also here met with, belonging to the genus *Goniatites.*

Beneath the Coal rests the Carboniferous Limestone, sometimes with the Millstone Grit between. The Carboniferous Limestone is for the most part a truly marine deposit, often rich in Corals and huge Brachiopods, *Productus giganteus,* with large Gasteropods, *Euomphalus, Macrocheilus,* etc., and with several species of *Trilobites*—another truly extinct order of Crustacea (unless, as I have ventured to suggest elsewhere, the *Trilobita* are but a lower form of *Isopoda,* less highly developed and less differentiated than those of to-day). Abundant and beautiful forms of *Crinoidea* occur in these rocks, often forming entire strata of vast thickness by the fragments of their stems alone, as witness the Entrochal marble and the Screw-stone of Derbyshire.[1] The Encrinite marble is so extensive as to be quarried for mantelpieces and other economic purposes. This marble also yields a new type of Nautiloid shell (but unrolled and *straightened* out), the *Orthoceras,* one of the earliest of the group.

And here I may be permitted to observe that both at the outset in the Palæozoic rocks, and also in the Chalk, Gault, and Neocomian strata, near the close of the epoch of the *Tetrabranchiate* Cephalopoda (or four-gilled division of this order of Mollusca), of which the *Nautilus* alone survives, they appear and disappear, as it were, *in contortions.* In fact, these chambered shells assume the most varied curves, spirals, and discoidal twists conceivable, as if undergoing torture, or practising fashions.

Nor can I divest my mind of the idea that *mimicry* (as Dr. Darwin, Mr. Wallace and many other Naturalists have pointed out) amongst animals of to-day was practised *at a very remote period,* and by very different forms of life.

Thus in the Solenhofen Limestone I believe long-tails were at one time set forth in the fashion-book of the period; for we have a long-tailed bird (the *Archæopteryx*), a long-tailed Pterodactyle (the *Rhamphorhynchus*), a long-tailed Crab, the King-Crab. Tails among Reptiles have been mostly in vogue—the earlier Frogs even wore tails, and their babies keep up the remembrance yearly, but drop them as soon as they come ashore.

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[1] The *Woodocrinus,* a beautiful form of stone-lily, only occurs at one particular locality, *in the Carboniferous Limestone* near Richmond, Yorkshire.

Here we take leave of our Reptilian friends, and go on further back in time, with only Fishes to remind us of "*animals with backbones.*" But swelling with the portents of future races, which shall arise to call him ancestor, behold the giant *Pterygotus*—largest of Palæozoic Crustacea, rivalling in size even the existing *Inachus Kæmpferi* from Japan, and far more muscular. Doubtless, in his day, both in the Upper Silurian and in the Devonian, he played an important part, devouring all things which came in his way, both old and new, living and putrid; like the existing members of his family, he had not a high stomach!

Still evidences of land! Mr. Samuel Scudder, of Boston, has described several Devonian Insects; Dr. Dawson, of Montreal, Mr. Baily, of the Irish Survey, the late Prof. Forbes, and others, have described *several* Devonian land-plants. Corals, as in the Carboniferous Limestone, were plentiful, and many formed reef-like masses of great size and compactness. A peculiar form of Trilobite with a large fan-tail (*Bronteus flabellifer*), and more Brachiopoda.

The fishes have a tendency to imitate King-Crabs; their bucklers are peculiarly Crustacean-looking—another case of mimicry: who set the fashion? and who followed?

Judging by the numbers of Trilobites and Crinoids, we have reached the "*Kingdom of Siluria,*" and behold the rich treasures of the Wenlock Limestone, its stores of Brachiopoda, its oldest King-Crab, *Neolimulus falcatus*, its queer *Pterygoti*, its Corals and earliest remains of Fishes. But time would fail to tell in detail the fauna of each rock of Ludlow, Wenlock, Woolhope, Llandovery, Caradoc and Bala, Llandeilo and Arenig, each a world of ages in antiquity, but still full of Crinoidea, Starfishes, Trilobites, and Lampshells, with varied forms of Orthocerata.

And now, wreathed in *Graptolites*, comes the Cambrian, with its Slate-rocks, and more new Trilobites, a Starfish and a Crinoid, Lingulæ and Zoophytes. Again rock-mass succeeds to rock-mass: Tremadoc-slates, Lingula-flags, Harlech-grits, Llanberis-slates. Is this the last? No, emphatically. Logan in Canada has added yet another conquest, and brought in *the great Laurentian* kingdom, with its (as yet) single fossil, the *Eozoon Canadense.*

What is this *Eozoon Canadense*? This to us, *at present*, oldest known form of life.

I have already spoken of the "Nummulitic formation," a limestone of Eocene Tertiary age, extending from England to China in a broad band, and in thickness sufficient to help to build up the Pyrenees, the Alps, the Atlas Mountains, the Carpathians, and even the mountains of Asia, extending into China and Thibet.

This limestone is made up largely (often entirely) of the lenticular *shells* of Nummulites. *Instead of shells, imagine it one shell,* one animal, and you have a notion of what *Eozoon* is like.

I have told you of the Chalk, covering an area as large as Europe, being largely composed of the shells of a microscopic Foraminifer called *Globigerina.* Instead of many shells, imagine it *one shell,* and you have a notion of what *Eozoon* is like.

But you will probably say, "This is too much to ask one to accept; the idea of a kind of common composite animal, however simple, stretching from the shores of Labrador to the margin of Lake Superior, and thence northwardly to an unknown distance, constituting a wild and rugged region, often rising into hills 4000 feet high, and forming cliffs 1500 feet sheer vertical depth!"

Let us instead look for a moment at the Pacific Ocean. Not an island in the intertropical region that lifts its head above the wave but is made of, *or fringed with*, Coral Reefs. Florida and the West Indian Islands, as well as those of the Indian Ocean, within the tropics, are alike coral-bound or coral-built. Here then, I think, we shall find a parallel instance, derived from a higher grade (the Zoophyta), in which composite animals are world-makers on fully as large a scale as the *Eozoon Canadense*, if not larger.

Speaking of the Atlantic mud, Prof. Wyville Thomson writes: "The mud was entirely filled with the delicate siliceous root-fibres of the vitreous sponges, binding it together, and traversing it in all directions like hairs in mortar. *This mud* (he goes on to say) *was actually alive*; it stuck together in lumps, as if there were white of egg mixed with it, and the glairy mass proved under the microscope to be living sarcode. Prof. Huxley regards this as a distinct creature, and calls it "Bathybius." Wyville Thomson inclines to look upon it as "simply a sort of diffused *mycelium* of the different distinct sponges growing at the bottom." "This view," he adds, "accords well with the mode of nutrition of the sponges."

This *Bathybius* agrees exactly with Huxley's description of his universal basis of life, or *Protoplasm*, which he traces in so many and various bodies, and which behaves like an ordinary *Amœba*, "drawing in and thrusting out prolongations of its substance."

Whether the so-called *Protoplasm* is, or is not, the ultimate basis of life,—whether it grows naturally from dead matter on which it feeds, as the brewer supposes the beer or wine to feed on the lees,—whether it can be made as a chemical compound from the elements of which it is composed,—we are not yet prepared to state. But I have been enabled to show you in a very rough and hasty way —(1) That the oldest organism with which we are acquainted is one of the simplest, being an aggregate of a number of Foraminifera associated together so as to form a common Protozoan Reef, just as a Coral island is a Zoophytan Reef. (2) That the Chalk and Nummulitic Limestone have been similarly built up of aggregations of myriads of Protozoans filled with the same sarcode, or *Protoplasm*, as the Eozoon. (3) That each geologic period as we ascend stage by stage upwards in the chronology of our Earth does not point to a periodic *re-creation of all things*, but rather tends to show that a gradual development of life has been taking place ever since its first appearance.

We *have not* a perfect and complete history of life on the globe, nor is it a thing to be ever expected. Geologists *have learned* to say "*we don't know*" about a great many things which at one time they either *thought they did* know, or they were credited by their *friends with such prescience.*

But making every allowance for our ignorance of past life-periods, and also for the imperfection of the geological record, I think it can be clearly demonstrated that there is "*a continuity of life on the earth*" from the earliest dawn of that life to our own day: that the changes which have taken place have resulted from alterations in physical conditions, such as the elevation and subsidence of the land, bringing about changes of climate, causing migrations and modifications in distribution, in numbers, size, etc. That from period to period, in the far-off past, the various groups have in turn prevailed as leaders in the kingdom of animal and vegetable life. Thus in early times the *Cephalopoda* ruled, later on the *Crustacea* came to the fore, then probably *Fishes* took the lead, but were speedily overpowered by the Saurians. These Land and Sea Reptiles then prevailed until *Mammalia* appeared upon the scene, since when it doubtless became a struggle for supremacy until Man was created. Then came the age of Invention; at first of flint and bone implements, of bows and arrows and fish-hooks; then of spears and shields, swords and guns, lucifer-matches, railways, electric telegraphs; since when even the great whale has given in his adhesion to the new King *Steam*, and is dying out of the way quietly.

One fact more deserves to be borne in mind: that is, the immensity of time since life first began. Originally only Plutonic or Metamorphic rocks existed. As these yielded to weathering, they produced sediments which assisted to form the Palæozoic rocks. Again, these in their turn were denuded wherever elevated above the sea, and assisted to form by their wreck the Mesozoic strata, from all of which the Tertiary have in like manner been made. But animals, by their labours and accumulated skeletons, have probably contributed more largely than any other source to build up the masses of the sedimentary rocks. Nor is it to the highest in the zoological scale that this task of mountain-building has been entrusted by Nature; on the contrary, the two humblest classes, the PROTOZOA and CŒLENTERATA, have been chosen to rear these imperishable monuments; whilst our great stores of mineral fuel, upon the *continuity* of which the vast industries of this country depend, are the result of the accumulated growth and decay of lowly organized Cryptogamic plants, allied to our existing Club-mosses and Equisetaceæ.

II.—NOTES ON CARBONIFEROUS *LAMELLIBRANCHIATA* (MONOMYARIA).

By ROBERT ETHERIDGE, Junior, F.G.S.

Genus PECTEN, Bruguière.

(PLATE XIII.)

PECTEN SOWERBII, McCoy. Plate XIII. Figs 1 and 2.

P. Sowerbii, McCoy. Synop. Carb. Fos. 1844, p. 100, pl. 14, fig. 1.
P. Valdaicus, Keyserling and De Verneuil. Murchison's Geol. Russia, 1845, vol. ii. p. 328, pl. 27, fig. 9.
" " D'Orbigny. Prodrome de Pal. 1849, i. p. 138.
P. Bathus, D'Orbigny. Prodrome de Pal. 1849, i. p. 139.
P. Sowerbii, Morris. Cat. Brit. Fos 1854, p. 175.
Amusium Sowerbii, McCoy. Brit. Pal. Fos. 1855, p. 478.

P. Valdaicus, Huxley and Etheridge. Cat. Fos. Mus. Pract. Geol. 1865, p. 110.
P. Sowerbii, Huxley and Etheridge. Cat. Fos. Mus. Pract. Geol. 1865, p. 109.
Aviculopecten Sowerbii, Armstrong and Young. Cat. Carb. Fos. W. Scot. Trans. Geol. Soc. Glasgow, 1871, iii. app. p. 47.
P. (*Pseud-amusium* ?) *Bathus*, De Koninck. Rech. Anim. Fos. Carb. Bleiberg, 1873, p. 94, pl. 3, fig. 19.

Sp. chars.—Shell ovato-elliptical, or suborbicular, slightly convex in the median line, flattened towards the margin; ears small, pointed, depressed, triangular, subequal, connate, their apices elevated above the level of the beaks, forming a re-entering angle, nearly at right angles with the general periphery of the shell, both separated from the body of the shell, with their outer edges convex; umbones simple, straight, and pointed; muscular impression large, and situated near the beaks and posterior margin; shell thin and delicate; surface ornamented with numerous close, fine, concentric lines.

Obs.—When the shell is removed, the inner lamina is seen to be covered with a series of beautiful V-shaped or zigzag markings, very acute about the convex centre of the shell, but becoming expanded and opened out towards the margins. The true shell often has the appearance of a thin, almost smooth or slightly wrinkled skin, with here and there a few concentric lines of growth; now and then, under certain conditions of preservation, a number of fine lines may be seen in the substance of the true shell, especially when held at an oblique angle; these are probably a more perfect condition of parts of some of the V-shaped striæ.

P. Sowerbii undergoes a considerable amount of change in form, according to the pressure to which the specimens have been subjected. We frequently find two deep grooves extending from the beaks, one on each side; the lateral portion of the shell from these grooves to the margins becomes much flattened, and in some cases even concave, but notwithstanding this, still retaining on the surfaces from which the shell has been removed the characteristic V-shaped markings. Again, pressure appears to impart to it a certain inequilateral aspect, so much so in some cases as to lead one to doubt the true specific identity of the specimen in question.

The present species was originally described by McCoy from an Irish specimen; but it was not until the publication of his large work on the "British Palæozoic Fossils" that the peculiar V-striæ were noticed. In this work the species was referred to Klein's genus *Amusium*, from the re-entering angle formed by the ears of the shell. Under the name of *P. Valdaicus*, Keyserling and De Verneuil had in the mean time figured the lower part of *P. Sowerbii*, showing the characteristic markings, from the Carboniferous series of Russia. It is also the *P. Bathus* of D'Orbigny.

Prof. de Koninck has lately pointed out[1] that Mr. Meek has proposed for similar pectiniferous shells the generic name of *Entolium*, but that this corresponds in a great measure with the section or subgenus *Pseud-amusium* of Klein, in which the learned Professor places *P. Sowerbii*. He further remarks that it has considerable affinity with *P. aviculatus*, Swallow.

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[1] *Descr. Anim. Fos.* Bleiberg, p. 95.

Goldfuss has figured in his "Petrefacta Germaniæ" two shells closely allied to *P. Sowerbii*. One, *P. striolutus*, from the transition limestone of the Eifel, has the re-entering angle formed by the ears and the general characters of our Carboniferous species, but with longitudinal striæ in the place of concentric lines.[1] The other, distinguished as *P. Phillipsii*, from the Greywacké of the Glatz district, Silesia, possesses concentric lines,[2] and altogether shows a great resemblance to *P. Sowerbii*.

In their description of *P. Valdaicus*, Count Keyserling and M. de Verneuil point out the affinity borne by their shell to *P. tenuistriatus*, Münster, from the German Muschelkalk; if not identical, the shells are very closely allied.

In the elevation of the ears above the general periphery of the shell, *P. Sowerbii* approaches some Oolitic *Pectens* (McCoy). If we are to regard the present shell other than as a true *Pecten*, it appears to me that Klein's genus *Amusium* is the correct resting-place for it, as placed by McCoy. Tate describes the latter in the following words: "Shell nearly equivalve, gaping in front and behind; smooth outside, generally marked with radiating lines inside."[3]

In nearly all cases where I have examined casts or decorticated specimens of *P. Sowerbii*, the V-striæ appear as hollow grooves, imparting the idea that they had been caused by the decomposition of some special substance entering into the composition of the shell, of a more destructible nature than its chief constituents.

In a specimen from a shale of the Second Kingshaw Limestone, near Carluke, I have distinctly seen the cartilage pit in the hinge under the beaks.

The distinguishing characters of *P. Sowerbii* are undoubtedly the general form and surface ornamentation, form and position of the ears, and when seen the V-striæ.

Localities and Position.—The chief localities are the following—*England:* Longnor, Derbyshire (Mus. Pract. Geol.); Lowick, Northumberland (McCoy).—*Scotland:* Lockridge Quarry, near Stewarton, Ayrshire; Fernie Hill, near Gilmerton, Edinburghshire, both in the shale of the Main Limestone; Shield burn, near Benthall, E. Kilbride, in shale bands in ash below Main Limestone; Teiglam burn, Lesmahagow, in shale over the Wee Limestone; Cleekhimin Quarry, near Carluke, Thorn Farm Quarry, near Carluke, and Snabe Quarry, near Strathavon, all in shale below the Main Limestone; Ponfeigh burn, near Douglas, in shale above the Main Limestone; Calderwater, near Basket Farm, E. Kilbride, in shales of the Crossbasket Ironstone Series; Mayfield Ironstone and Limestone Pit, near Carluke, Lochknowe Pit (No. 5), Kingshaw Moss, near Carluke, in shale above the Second Kingshaw Limestone (Geol. Survey Scotland). Carluke, in *Lingula* Ironstone (Armstrong and Young). Calderwater, opposite Old Mines of Calderside, and Newfield Quarry, near E. Kilbride, in shale between the First and Second Calderwood Limestones; Burnbrae Old Quarry, near E. Kilbride, in shale below the Calderwood Cement Stone; Kirktonholm Cement Works and Glebe Quarry, E. Kilbride, in the Calderwood Cement Stone (Geol. Survey Scotland). Cunningham Bedland, Craigenglen, and Corrie burn, in the Lower Limestone (Armstrong and Young). The foregoing are all in the Lower Carboniferous Limestone Group. Birkwood burn, near Lesmahagow, in the shales of the McDonald Clayband Ironstone, Middle Limestone, or Coal and Ironstone Group[1] (Geol. Survey Scotland). The following is in the Upper Carboniferous Limestone Group: Gillfoot House, near Carluke, in shale above the Gillfoot or Belston Burn Limestone (Geol. Survey Scotland).[2] Mr. C. W. Peach has also obtained this shell from black shale at the Abbey Craig, Bridge of Allan. The original Irish localities are Brucklers, in yellow sandstone; Linsapaste, in Carboniferous slate; and in the Culm of Bundoran, Ballintrillick (McCoy).

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[1] Plate 160, fig. 7.

[2] *ibid.* fig. 6.

[3] *Ralph Tate,* in Woodward's Manual of Mollusca, 1868, second edition, p. 412.

In Russia, recorded as *P. Valdaicus*, from Limestone at the base of the Carboniferous series on the borders of Bistriza (Valdai). Prof. de Koninck records it from Bleiberg (Carinthia).

Genus AVICULOPECTEN, McCoy.

AVICULOPECTEN ORYZA,[3] R. Etheridge, jun.

A. oryza, R. Etheridge, jun. Mems. Geol. Survey, Expl. 23, Scotland, 1873, p. 103.

This name was proposed for two portions of a curiously marked pectiniferous shell, which, although fragments, differ so widely in their ornamentation from that generally found in this genus as to be worthy a specific name. One piece shows the remains of the ears and upper portion of the shell, and the other that of the ventral or lower part. The ears appear to have been small. The shell is thin, and covered with peculiar blob-like depressions, arranged in consecutive lines, the markings of one line alternating with those of the next, and so on. These depressions present an appearance as if a number of grains of rice had been uniformly pressed on the surface of the shell, and then removed, leaving behind them impressions of their forms. Those portions preserved show that when perfect the shell was of some considerable size.

Locality and Position.—Merry and Cunningham's Limestone Pit, near Carluke, Lanarkshire, in shale above the Second Kingshaw Limestone (Geol. Survey Scotland). Collected by Mr. J. Bennie.

AVICULOPECTEN ELLIPTICUS, Phillips. Plate XIII. Fig. 3.

Pecten ellipticus. Phil. Geol. York. 1836, ii. p. 212, pl. 6, fig. 15.
—————— McCoy. Synop. Carb. Fos. 1844, p. 92.
—————— Morris. Cat. Brit. Fos. 1854, p. 164.
—————— Huxley and Etheridge. Cat. Fos. Mus. Pract. Geol. 1868, p. 110.

Sp. chars.—Ovate, most convex below the beaks, but generally much compressed and flattened towards the margins, becoming elongate with pressure; hinge-line short, straight; ears small, subequal, the posterior somewhat the larger, both delicately striated vertically; shell very thin, papyraceous, and nearly smooth, often wrinkled irregularly; muscular scar large and sub-central.

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[1] The Lower Coal-measures of some writers.

[2] The Survey *specimens were collected* by Messrs. Bennie and Macconochie.

[3] *Gr. ορυζα, rice.*

Obs.—I have ventured to refer Fig. 3 to Phillips's *P. ellipticus*, notwithstanding the very short description and imperfect figure of the former; but it appears to me to correspond better with the characters of the species as given by Phillips and McCoy than with any other of our British *Aviculopectens*. It has great affinities with *Pecten Sowerbii*, so much so indeed, that were not the ears placed after the usual manner of the genus, instead of at an elevated angle, as in the former, one would be inclined to refer it to that species, more especially when in compressed specimens the grooves from the beaks down the sides of the shell are present, consequent on pressure. The ears are the only portion upon which any ornamentation is traceable, as the body of the shell is quite devoid of radiating, and with but few and wide apart concentric lines. McCoy mentions the existence of colour markings, dark zigzag on a light ground. Like that of *P. Sowerbii*, the shell of *A. ellipticus* was very thin, even more so I imagine, sometimes presenting quite a shrivelled appearance. Under the name of *P. inornatus* (Phil.), McCoy briefly described[1] another species, the characters of which also closely correspond with those of the present shell. I have been unable to find Phillips's original description, but McCoy states that the surface is "concentrically waved with obtusely rounded, smooth wrinkles." May not the two shells *A.* (*Pecten*) *ellipticus* and *P. inornatus* be the same under slightly different aspects? I have never seen a specimen of *P. inornatus*, so merely throw out the suggestion. Two specimens of an *Aviculopecten* have come under my notice presenting the ovate form, and small striated ears of the present species, with the shell removed, showing the V-striæ so characteristic of *P. Sowerbii*. Whether *A. ellipticus* also had these markings, the materials at hand do not permit me to state with any certainty.[2]

Localities and Position.—Calderwater, near Tower on Calderwood Grounds, near E. Kilbride, Lanarkshire, in shale of the Crossbasket Ironstone series; Mayfield Ironstone and Limestone Pit, near Carluke, in shale above the Second Kingshaw Limestone; Calderwater, opposite Old Mines of Calderside, near E. Kilbride, in shale above the Second Calderwood Limestone, all in the Lower Carboniferous Limestone Group. In the Upper Carboniferous Limestone Group, old quarry near Andershaw, Glespin Water, near Douglas, Lanarkshire, in shale between two beds of Limestone (Geol. Survey Scotland); Teiglam Burn, Lesmahagow (C. W. Peach), in black shale.

Genus POSIDONOMYA, Bronn (=POSIDONIA, Bronn).

POSIDONOMYA CORRUGATA, Etheridge. Plate XIII. Figs. 4, 5, and 6.

Anomia corrugata, Etheridge, MS. Armstrong and Young's Cat. Carb. Fos. W. Scot., Trans. Geol. Soc. Glasgow, 1871, iii. app. p. 45. (no descrip.)

Posidonomya corrugata, R. Eth., jun. Mems. Geol. Surv. Expl. 32, Scot., 1873, p. 103.

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[1] Synopsis Carb. Fossils, 1844, p. 94.

[2] My friend Mr. C. W. Peach has lately shown me another specimen of a valve possessing the small ears of this species, and ornamented with the V-striæ of *P. Sowerbii*. I find that in some notes attached to the description of *Pernopecten Shumardianus*, Winchell, Messrs. Meek and Worthen state that one of them (Mr. Meek) has described, in the "Report on the Coal-measure Fossils of Nebraska" (a work I have unfortunately not seen), a shell with the hinge-line in one valve straight,

Sp. chars.—Variable in outline, but generally irregularly ovate, compressed, occasionally assuming an oblique form, at times narrowed towards the beaks, and expanded towards the ventral margin; beaks, in the ovate forms nearly central, in the oblique forms nearer the anterior end, sharp, prominent; anterior end rounded; posterior end somewhat truncated; the distinguishing character of the shell is the very irregular concentric wrinkles which cover the surface; in nearly all adult specimens these are supplemented by a variable number of strongly wrinkled ribs, which radiate from the beak to the ventral margin on the centre of the shell only, leaving the anterior and posterior ends merely covered with the concentric markings; shell thin.

Obs.—This shell was originally regarded as a species of *Anomia*, but the examination of a large series of specimens, many showing both valves united, has convinced me that it has nearer affinities with *Posidonomya*. Not a single specimen has shown the perforated valve of *Anomia*. *Posidonomya Gibsoni*, Brown,[1] is a closely allied shell, and is equally variable and coarsely wrinkled, but wants the radiating ribs. In the possession of the latter, *P. corrugata* approaches McCoy's *P. costata*,[2] but has in addition the concentric wrinkles, which are absent in the Irish shell. In this species the adiating ribs are confined to the number four in each individual, whilst in *P. corrugata* they are variable, as few as two and as nany as seven have been noted. Highly gregarious, and at certain ocalities very common.

Locality and Position.—North Lickprivick Farm Old Quarry, near
Kilbride, Lanarkshire, in shale above the Main Limestone;
iddler's burn, opposite Headsmuir, near Carluke, Lanarkshire, in
hale below Raesgill Ironstone; Jock's burn above Hallcraig Bridge,
ear Carluke, in shale between the First Kingshaw Limestone and the
ingula Limestone, and also in the latter; Burnbrae Old Quarry, Gill
urn, Quarry near Mossneuk Farm House, and burn under Burn-
ead Farm House, all near E. Kilbride, in shale immediately below
alderwood Cement Stone; Old Quarry, near Limekilns House,
ear E. Kilbride, in the Calderwood Cement Stone; Kirktonholm
ement Works, Calderside Cement Works, Boghead Quarry, and
wfield Farm Cement Works, all near E. Kilbride, in shale above
lderwood Cement Stone (Geol. Survey of Scotland).[3]

EXPLANATION OF PLATE XIII.

. 1.—*Pecten Sowerbii*, McCoy. Showing the conate ears and V-striæ. Slightly enlarged. L. Limestone series. Esperston, near Edinburgh.

. 2.—Another specimen, much compressed, with the ears wanting.

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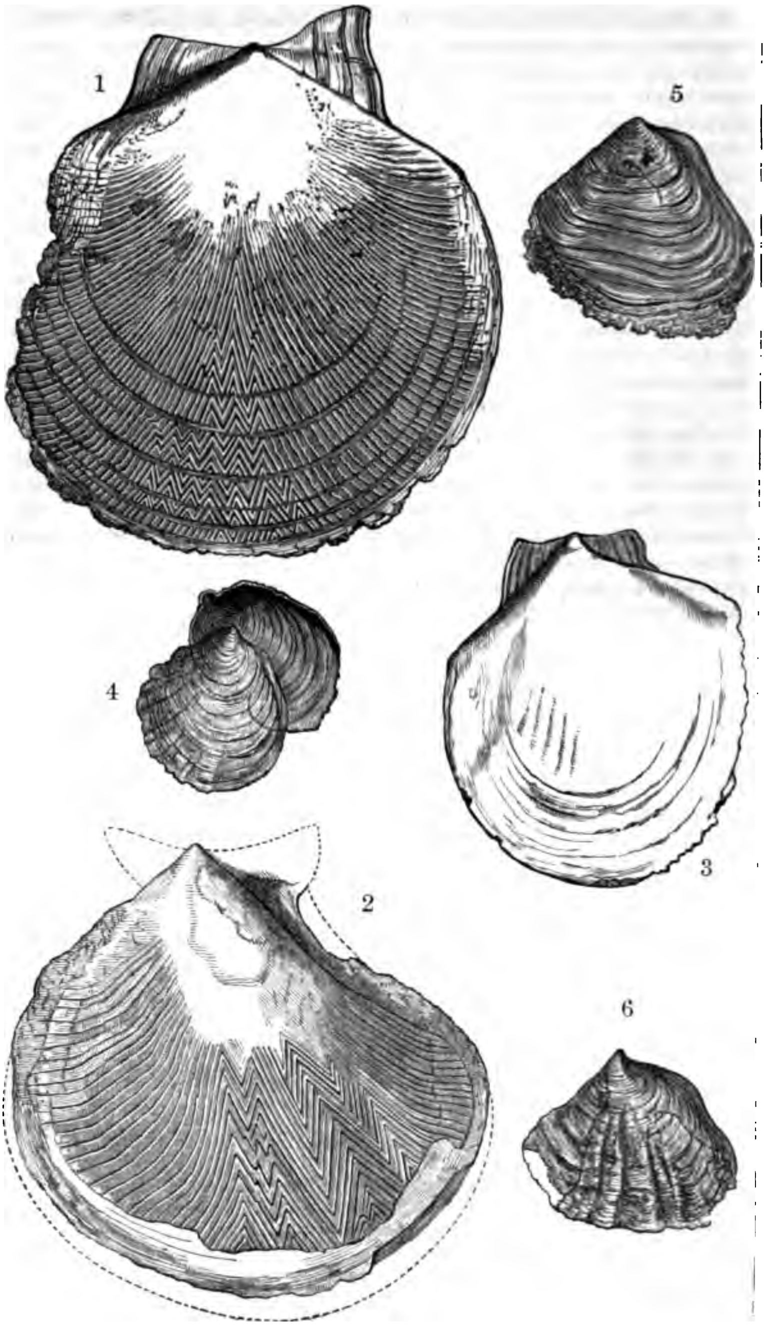
in the other forming, at the beaks, a retreating angle (Illinois Geol. Rep. iii.
e 454). It may be that the two valves of *P. Sowerbii* differed in a somewhat
logous manner; this, however, is a point which can only be proved by those pos-
ing specimens showing the valves in union. Messrs. Meek and Worthen point
the resemblance of *P. Shumardianus* to *P. Sowerbii*.

Salter, Mems. Geol. Survey England and Wales, Country around Wigan, 1862,
5, *fig. 1, b*.

Synop. Carb. Fos. 1844, p. 78, t. 13, fig. 15.

Recorded as *Anomia corrugata* by Messrs. Armstrong and Young, from Boghead,
hin band of Limestone, in the Upper Black Shale, and Dalrey, Ayrshire, in the
r Limestone. (Trans. Geol. Soc. Glasgow, iii. app. p. 45.)



To illustrate paper by Mr. Robert Etheridge, jun., on Scottish Carboniferous Mollusca.

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[1] Salter, Mems. Geol. Survey England and Wales, Country around Wigan, 1862, 35, fig. 1, *b*.

[2] Synop. Carb. Fos. 1844, p. 78, t. 13, fig. 15.

[3] Recorded as *Anomia corrugata* by Messrs. Armstrong and Young, from Boghead, a thin band of Limestone, in the Upper Black Shale, and Dalrey, Ayrshire, in the ower Limestone. (Trans. Geol. Soc. Glasgow, iii. app. p. 45.)

FIG. 3.—*Aviculopecten ellipticus*, Phillips. Natural size. Shale of the L. Carboniferous Limestone series. Teiglam Burn, Lesmahagow.

FIGS. 4, 5, and 6.—*Posidonomya corrugata*, Etheridge. Shale above the Calderwood Cement Stone, L. Carboniferous Limestone Group, Kirktonholm Cement Works, E. Kilbride.

For the specimen from which Fig. 1 is taken I am much indebted to Mr. James Bennie, who obtained it from the locality above mentioned. The original of Fig. 3 was kindly lent me by Mr. C. W. Peach; and those from which Figs. 4, 5, and 6 were drawn, are from the collection of Mr. A. Paton, of E. Kilbride, who obtained them at the locality mentioned, and to whom I am much indebted for an opportunity of examining numerous other fossils from that district.

III.—ON THE PHYSICAL CAUSE OF THE SUBMERGENCE AND EMERGENCE OF THE LAND DURING THE GLACIAL EPOCH.

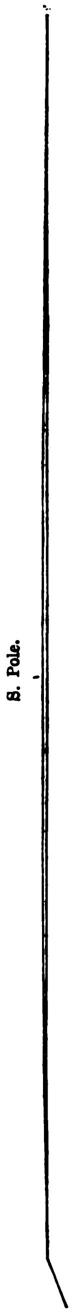
By JAMES CROLL, of the Geological Survey of Scotland.

AN ordinary glacier descends in virtue of the slope of its bed, and, as a general rule, it is on this account thin at its commencement, and thickens as it descends into the lower valleys, where the slope is less and the resistance to motion greater. But in the case of continental ice, matters are entirely different. The slope of the ground exercises little or no influence on the motion of the ice. In a continent of one or two thousand miles across, the general slope of the ground may be left out of account; for any slight elevation which the centre of such a continent may have will not compensate for the resistance offered to the flow of the ice by mountain ridges, hills, and other irregularities of its surface. The ice can move off such a surface only in consequence of pressure acting from the interior. In order to produce such a pressure, there must be a piling up of the ice in the interior; or, in other words, the ice-sheet must thicken from the edge inwards to the centre. We are necessarily led to the same conclusion, though we should not admit that the ice moves in consequence of pressure from behind, but should hold, on the contrary, that each particle of ice moves by gravity in virtue of its own weight; for in order to have such a motion, there must be a slope, and as the slope is not on the ground, it must be on the ice itself: consequently, we must conclude that the upper surface of the ice slopes upwards from the edge to the interior. What, then, is the least slope at which the ice will descend? Mr. Hopkins found that ice barely moves on a slope of one degree. We have therefore some data for arriving at least at a rough estimate of the probable thickness of an ice-sheet covering a continent, such, for example, as Greenland or the Antarctic Continent.

The Antarctic Continent is generally believed to extend, on an average, from the South Pole down to about, at least, latitude 70°. In round numbers, we may take the diameter of this continent at 2800 miles. The distance from the edge of this ice-cap to its centre, the South Pole, will, therefore, be 1400 miles. The whole of this Continent, like Greenland, is undoubtedly covered with one continuous sheet of ice gradually thickening inwards from its edge to its centre. A slope of one degree continued for 1400 miles will give twenty-four miles as the thickness of the ice at the Pole. But suppose the slope of the upper surface of the cap to be only one-half this amount, viz. a half degree,—and we have no evidence that a

.ll would be sufficient to discharge the ice,
ıave twelve miles as the thickness of the
Pole. To those who have not been ac-
reflect on the physical conditions of the
s estimate may doubtless be regarded as
ɛtravagant; but a slight consideration will,
ɔw that it would be even more extravagant
ıat a slope of less than half a degree would
to produce the necessary outflow of the
imating the thickness of a sheet of con-
of one or two thousand miles across, our
is apt to deceive us. We can easily form
ırate sensuous representation of the thick-
sheet; but we can form no adequate re-
of its superficial area. We can represent
with tolerable accuracy a thickness of a
ut we cannot do this in reference to the
rface 2800 miles across. Consequently, in
ıt proportion the thickness of the sheet
to its superficial area, we are apt to fall
ır of under-estimating the thickness. We
king example of this in regard to the
thing which impresses us most forcibly
the ocean is its profound depth. A mean
y, three miles produces a striking impres-
we could represent to the mind the vast
ocean as correctly as we can do its depth,
rather than *depth* would be the impression
A sheet of water one hundred yards in
.d only one inch deep, would not be called
very *shallow* pool or thin layer of water.
layer would be a correct representation of
ı miniature. Were we in like manner to
the eye in miniature the Antarctic ice-
ıld call it a *thin crust* of *ice*. Taking the
ıess of the ice at four miles, the Antarctic
ɔuld be represented by a carpet covering
an ordinary-sized dining-room. Were
ɔnsider the above estimate of the thickness
ctic ice-cap as extravagantly great called
tch on paper a section of what they should
of moderate thickness, ninety-nine out of
.red would draw one of much greater
an twelve miles at the centre.

mpanying diagram represents a section
ɔap drawn to a natural scale; the upper
he sheet having a slope of half a degree.
looking at the section would pronounce it
ck at the centre, unless he were previously
that it represented a thickness of twelve



Section across Antarctic Ice-cap, drawn to a natural scale.
Length represented by section = 2800 miles. Thickness at centre (South Pole) = 12 miles.
Slope of upper surface = half-degree.

miles at that place. It may be here mentioned that had the section been drawn upon a much larger scale—had it, for instance, been made seven feet long, instead of seven inches—it would have shown to the eye in a more striking manner the thinness of the cap.

But to avoid all objections on the score of over-estimating the thickness of the cap, I shall assume the angle of the upper surface to be only a quarter of a degree, and the thickness of the sheet one-half what it is represented in the section. The thickness at the Pole will then be only six miles instead of twelve, and the mean thickness of the cap two instead of four miles.

Is there any well-grounded reason for concluding the above to be an over-estimate of the actual thickness of the Antarctic ice? It is not so much in consequence of any *à priori* reason that can be urged against the probability of such a thickness of ice, but rather because it so far transcends our previous experience that we are reluctant to admit such an estimate. If we never had any experience of ice thicker than what is to be found in England, we should feel startled on learning for the first time that in the valleys of Switzerland the ice lay from 200 to 300 feet in depth. Again, if we had never heard of glaciers thicker than those of Switzerland, we could hardly credit the statement that in Greenland they are actually from 2000 to 3000 feet thick. We, in this country, have long been familiar with Greenland; but till very lately no one ever entertained the idea that that continent was buried under one continuous mass of ice, with scarcely a mountain top rising above the icy mantle. And had it not been that the geological phenomena of the Glacial epoch have for so many years accustomed our minds to such an extraordinary condition of things, Dr. Rink's description of the Greenland ice would probably have been regarded as the extravagant picture of a wild imagination.

Let us now consider whether or not the facts of observation and experience, so far as they go, bear out the conclusions to which physical considerations lead us in reference to the magnitude of continental ice; and more especially as regards the ice of the Antarctic regions.

First. In so far as the Antarctic ice-sheet is concerned, observation and experience to a great extent may be said to be a perfect blank. One or two voyagers have seen the outer edge of the sheet at a few places, and this is all. In fact, we judge of the present condition of the interior of the Antarctic Continent in a great measure from what we know of Greenland. But, again, our experience of Greenland ice is almost wholly confined to the outskirts. No one, with the exception of Dr. Hayes and Prof. Nordenskiöld, has penetrated to any distance into the interior. Dr. Hayes's excursion was made, however, not upon the real inland ice, but upon a smaller ice-field connected with it; while Prof. Nordenskiöld's excursion was made at a place too far south to afford an accurate idea of the actual condition of the interior of North Greenland, even though he had penetrated much further than he actually did. However, the state of things as recorded by Hayes and by Nordenskiöld affords us a glimpse into the condition of things in the interior of the continent. They both found by observation, what follows as a necessary result from physical considerations, that the upper surface of the ice plain, under which hills and valleys are buried, gradually *slopes upwards towards the interior of the continent.* Prof. Nordenskiöld states that when at the extreme point at which he reached, thirty geographical miles from the coast, he had attained an elevation of 2200 feet, and "that the inland ice *continued constantly to rise* towards the interior, so that the horizon towards the east, north, and south, was terminated by an ice-border almost as smooth as that of the ocean." (GEOL. MAG. 1872, Vol. IX. p. 360.)

Dr. Hayes and his party penetrated inwards to the distance of about seventy miles. On the first day they reached the foot of the great Mer de Glace, the second day's journey carried them to the upper surface of the ice-sheet. On the third day they travelled thirty miles, and the ascent, which had been about 6°, diminished gradually to about 2°. They advanced on the fourth day about twenty-five miles; the temperature being 30° below zero (Fah.). "Our station at the camp," he says, "was sublime as it was dangerous. We had attained an altitude of 5000 feet above the sea-level, and were seventy miles from the coast, in the midst of a vast frozen Sahara immeasurable to the human eye. There was neither hill, mountain, nor gorge, anywhere in view. We had completely sunk the strip of land between the Mer de Glace and the sea, and no object met the eye but our feeble tent, which bent to the storm. Fitful clouds swept over the face of the full-orbed moon, which, descending towards the horizon, glimmered through the drifting snow that scudded over the icy plain—to the eye in undulating lines of downy softness, to the flesh in showers of piercing darts." (Open Polar Sea, p. 134.)

Dr. Rink, referring to the inland ice, says that the elevation or height above the sea of this icy plain at its junction with the outskirts of the country, and where it begins to lower itself through the valleys to the friths, is. in the ramifications of the Bay of Omenak, found to be 2000 feet, from which level *it gradually rises towards the interior.* (Journ. of the Royal Geographical Soc. 1853, vol. xxiii.)

Dr. Robert Brown, who, along with Mr. Whymper in 1867, attempted a journey to some distance over the inland ice, is of opinion that Greenland is not traversed by any ranges of mountains or high land, but that the entire continent, twelve hundred miles in length and four hundred miles in breadth, is covered with one continuous unbroken field of ice, the upper surface of which, he says, *rises by a gentle slope towards the interior.* ("Physics of Arctic Ice," Quart. Journ. Geol. Soc. for February, 1871.)

Suppose now the point reached by Hayes to be within 200 miles of the centre of dispersion of the ice, and the mean slope from that point to the centre, as in the case of the Antarctic cap, to be only half a degree; this would give 10,000 feet as the elevation of the centre above the point reached. But the point reached was 5000 feet above sea-level, consequently the surface of the ice at the centre of dispersion would be 15,000 feet above sea-level, which is about one-fourth what I have concluded to be the elevation of the surface of the Antarctic ice-cap at its centre. And supposing we assume the general surface of the ground to have in the central region an elevation as great as 5000 feet, which is not at all probable, still this would give 10,000 feet for the thickness of the ice at the centre of the Greenland Continent. But if we admit this conclusion in reference to the thickness of the Greenland ice, we must admit that the Antarctic ice is far thicker, because the thickness, other things being equal, will depend upon the size, or, more properly, upon the diameter of the continent; for the larger the surface, the greater is the thickness of ice required to produce the pressure requisite to make the rate of discharge of the ice equal to the rate of increase. Now the area of the Antarctic Continent must be at least a dozen of times greater than that of Greenland.

Second. That the Antarctic ice must be far thicker than the Arctic is further evident from the dimensions of the icebergs which have been met with in the Southern Ocean. No icebergs over three hundred feet in height have been found in the Arctic regions, whereas in the Antarctic regions, as we shall see, icebergs of twice and even thrice that height have been reported.

Third. We have no reason to believe that the thickness of the ice at present covering the Antarctic Continent is less than that which covered a continent of a similar area in temperate regions during the Glacial epoch. Take, for example, the North American Continent, or, more properly, that portion of it covered by ice during the Glacial epoch. Prof. Dana has proved that during that period the thickness of the ice on the American Continent must in many places have been considerably over a mile. He has shown that over the northern border of New England the ice had a mean thickness of 6500 feet, while its mean thickness over the Canada watershed, between St. Lawrence and Hudson's Bay, was not less than 12,000 feet, or upwards of two miles and a quarter (see American Journal of Science and Art for March, 1873).

Fourth. Some may object to the foregoing estimate of the amount of ice on the Antarctic Continent, on the grounds that the quantity of snowfall in that region cannot be much. But it must be borne in mind that, no matter however small the annual amount of snowfall may be, if more falls than is melted, the ice must continue to accumulate year by year till its thickness in the centre of the continent be sufficiently great to produce motion. The opinion that the snowfall of the Antarctic regions is not great does not, however, appear to be borne out by the observation and experience of those who have visited those regions. Capt. Wilkes, of the American Exploring Expedition, estimated it at thirty feet per annum. And Sir James Ross says that during a whole month they had only three days free from snow. The fact that perpetual snow is found at *the sea-level* at lat. 64° S. proves that the snowfall must be great.

But there is another circumstance which must be taken into account, viz. that the currents carrying moisture move in from all directions towards the Pole, consequently the area on which they deposit their snow becomes less and less as the Pole is reached, and this must, to a corresponding extent, increase the quantity of snow falling on a given area. Let us assume, for example, that the clouds in passing from lat. 60° to lat. 80° deposit moisture sufficient to produce, say, thirty feet of snow per annum, and that by the time they reach lat. 80° they are in possession of only one-tenth part of their original store of moisture. As the area between lat. 80° and the Pole is but one-eighth of that between lat. 60° and 80°, this would, notwithstanding, give twenty-four feet as the annual amount of snowfall between lat. 80° and the Pole.

Fifth. The enormous size and thickness of the icebergs which have been met with in the Southern Ocean testify to the thickness of the Antarctic ice-cap.

We know from the size of some of the icebergs which have been met with in the southern hemisphere that the ice at the edge of the cap where the bergs break off must in some cases be considerably over a mile in thickness, for icebergs of more than a mile in thickness have been found in the southern hemisphere. The following are the dimensions of a few of these enormous bergs taken from the Twelfth Number of the Meteorological Papers published by the Board of Trade, and from the excellent paper of Mr. Towson on the Icebergs of the Southern Ocean, published also by the Board of Trade.[1] With one or two exceptions, the heights of the bergs were accurately determined by angular measurement:—

Sept. 10th, 1856.—The "Lightning," when in lat. 55° 33′ S., long. 140° W., met with an iceberg 420 feet high.

Nov. 1839.—In lat. 41° S., long. 87° 30′ E., numerous icebergs 400 feet high were met with.

Sept. 1840.—In lat. 37° S., long. 15° E., an iceberg 1000 feet long and 400 feet high was met with.

Feb. 1860.—Captain Clark of the "Lightning," when in lat. 55° 20′ S., long. 122° 45′ W., found an iceberg 500 feet high and three miles long.

Dec. 1st, 1859.—An iceberg 580 feet high and from two and a half to three miles long was seen by Captain Smithers of the "Edmond" in lat. 50° 52′ S., long. 43° 58′ W. So strongly did this iceberg resemble land that Captain Smithers believed it to be an island, and reported it as such, but there is little or no doubt that it was in reality an iceberg. There were pieces of drift ice under its lee.

Nov. 1856.—Three large icebergs 500 feet high were found in lat. 41° 0′ S., long. 42° 0′ E.

Jan. 1861.—Five icebergs, one 500 feet high, were met with in lat. 55° 46′ S., long. 155° 56′ W.

Jan. 1861.—In lat. 56° 10′ S., long. 160° 0′ W., an iceberg 500 feet high and half a mile long was found.

Jan. 1867.—The barque "Scout" from the West Coast of America, on her way to Liverpool, passed some icebergs 600 feet in height and of great length.

April, 1864.—The "Royal Standard" came in collision with an iceberg 600 feet in height.

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[1] It is a pity that at present no record is kept, either by the Board of Trade or by the Admiralty, of remarkable icebergs which may from time to time be met with. Such a record might be *of little importance* to navigation, but it would certainly be *of great service to Science.*

Dec. 1856.—Four large icebergs, one of them 700 feet high, and another 500 feet, were met with in lat. 50° 14′ S., long. 42° 54′ E.

Dec. 25th, 1861.—The "Queen of Nations" fell in with an iceberg in lat. 53° 45′ S., long. 170° 0′ W., 720 feet high.

Dec. 1856.—Captain P. Wakem, ship "Ellen Radford," found in lat. 52° 31′ S., long. 43° 43′ W., two large icebergs, one at least 800 feet high.

Mr. Towson states that one of our most celebrated and talented naval surveyors informed him that he had seen icebergs in the southern regions 800 feet high.

Mar. 23rd, 1855.—The "Agneta" passed an iceberg in lat. 53° 14′ S., long. 14° 41′ E., 960 feet in height.

Aug. 16th, 1840.—The Dutch ship "General Baron von Geen" passed an iceberg 1000 feet high in lat. 37° 32′ S., long. 14° 10′ E.

May 15th, 1859.—The "Roseworth" found in lat. 53° 40′ S., long. 123° 17′ W., an iceberg as large as "Tristan d'Acunha."

In the regions where most of these icebergs were met with the mean density of the sea is about 1·0256. The density of ice is ·92. The density of icebergs to that of the sea is therefore as 1 to 1·115; consequently every foot of ice above water indicates 8·7 feet below water. It therefore follows that those icebergs 400 feet high had 3480 feet under water,—3880 feet would consequently be the total thickness of the ice. The icebergs which were 500 feet high would be 4850 feet thick, those 600 feet high would have a total thickness of 5820, and those 700 feet high would be no less than 6790 feet thick, which is more than a mile and a quarter. The iceberg 960 feet high sighted by the "Agneta" would be actually 9312 feet thick, which is upwards of a mile and three-quarters.

Although the mass of an iceberg below water compared to that above may be taken to be about 8·7 to 1, yet it would not be always safe to conclude that the thickness of the ice below water bears the same proportion to its height above. If the berg, for example, be much broader at its base than at its top, the thickness of the ice below water would bear a less proportion to the height above water than as 8·7 to 1. But a berg such as that recorded by Capt. Clark, 500 feet high and three miles long, must have had only $\frac{1}{8\cdot7}$ of its total thickness above water. The same remark applies also to the one seen by Capt. Smithers, which was 580 feet high, and so large that it was taken for an island. This berg must have been 5628 feet in thickness. The enormous berg which came in collision with the "Royal Standard" must have been 5820 feet thick. It is not stated what length the icebergs 730, 960, and 1000 feet high respectively were; but supposing that we make considerable allowance for the possibility that the proportionate thickness of ice below water to that above may have been less than as 8·7 to 1, still we can hardly avoid the conclusion that the icebergs were considerably above a mile in thickness. But if there are icebergs above a mile in thickness, then there must be land-ice somewhere on the southern hemisphere of that thickness. In short, the great Antarctic ice-cap must in some places be over a mile in thickness at its edge.

Few things have tended more to mislead geologists in the interpretation of glacial phenomena than inadequate conceptions regarding the magnitude of continental ice. Without the conception of *continental ice* the known facts connected with glaciation would be perfectly inexplicable. It was only when it was found that the accumulated facts refused to be explained by any other conception, that belief in the very existence of such a thing as continental ice became common. But although most geologists now admit the existence of continental ice, yet, nevertheless, adequate conceptions of its real magnitude are by no means so common. Year by year, as the outstanding facts connected with glaciation accumulate, we are compelled to extend our conceptions of the magnitude of land-ice. Take the following as an example. It was found that the transport of the Wastdale Crag blocks, the direction of the striæ on the islands of the Baltic, on Caithness and on the Orkney, Shetland, and Faroe islands, the Boulder-clay with broken shells in Caithness, Holderness, and other places, were inexplicable on the theory of land-ice. But it was so only in consequence of the inadequacy of our conceptions of the magnitude of the ice; for a slight extension of our ideas of its thickness have explained not only these phenomena,[1] but others of an equally remarkable character, such as the striation of the Long Island and the submerged rock-basins around our coasts described by Mr. James Geikie. In like manner, if we admit the theory of the Glacial epoch propounded in former papers,[2] all that is really necessary to account for the submergence of the land is a slight extension of our hitherto preconceived estimate of the thickness of the ice on the Antarctic Continent. If we simply admit a conclusion to which all physical considerations, as we have seen, necessarily lead us, viz. that the Antarctic Continent is covered with a mantle of ice at least two miles in thickness, we have then a complete explanation of the cause of the submergence of the land during the Glacial epoch.

Although of no great importance to the question under consideration, it may be remarked that, except during the severest part of the Glacial epoch, we have no reason to believe that the total quantity of ice on the globe was much greater than at present, only it would then be all on one hemisphere. Remove two miles of ice off the Antarctic Continent, and place it on the northern hemisphere, and this along with the ice that now exists on this hemisphere would equal, in all probability, the quantity existing on our hemisphere during the Glacial epoch; at least, before it reaches its maximum severity.

How much, then, would the transference of the two miles of ice from the southern to the northern hemisphere raise the level of the ocean on the latter hemisphere? This mass, be it observed, is equal to only one-half that represented in our section. A considerable amount of discussion has arisen in regard to the method of determining this point. According to the method detailed in my former papers ("Reader," Sept. 2nd, 1865; Phil. Mag. April, 1866), which supposes the rise at the pole to be equal to the extent of the displacement of the earth's centre of gravity, the rise at the North Pole would be about 380 feet, taking into account the effect produced by the displaced water; and the rise in the latitude of Edinburgh would be 312 feet. The fall of level on the southern hemisphere would, of course, be equal to the rise of level on the northern. According to the method advanced by Mr. D. D. Heath (Phil. Mag. for April, 1866, p. 323), the rise of level at the North Pole would be about 650 feet. Archdeacon Pratt's method (Phil. Mag. for March, 1866, p. 172) makes the rise still greater; while according to Rev. O. Fisher's method ("Reader," 10th Feb. 1866) the rise would be no less than 2000 feet. There is, however, another circumstance which must be taken into account, which will give an additional rise of upwards of one hundred feet.

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[1] See Geol. Mag. for May and June, 1870, and Jan. 1871.

[2] See Phil. *Mag. for March, 1870,* March, 1874, May, Aug. Nov. 1868.

(*To be continued.*)

IV.—ON THE GEOLOGY OF THE NOTTINGHAM DISTRICT.[1]

By the REV. A. IRVING, B.A., B.Sc., F.G.S.,
Second Master of the High School, Nottingham.

A GLANCE at the map shows that within a short distance of the town of Nottingham there are Coal-measures, Permian, Bunter, Keuper, and Lias rocks. A paper therefore on the district must of necessity be somewhat lengthy, but perhaps of all the greater interest as dealing with the border-land of the Palæozoic and Mesozoic epochs. The generally supposed unconformability between the Permian and Triassic rocks does not appear to exist in this area; while that between the Permian and the Coal-measures is very considerable.

(1). *Coal-measures.*—There are seven seams of coal at present worth working in this coal-field, with many more of inferior quality. The uppermost of the seven is the "Top-hard" or "Barnsley" Coal, the lowest the Kilburn Coal. Below the latter are the comparatively worthless strata known as the "Ganister Beds," which are found on the Derbyshire side of the coal-field, resting upon the Millstone-grit. The enormous unconformability between the Coal-measures and the Permian is shown by the fact that at the Shireoak Colliery, near Worksop, 1300 feet of Coal-measures had to be penetrated in sinking the shaft before the Top-hard seam was reached; while at Strelley, rather more than twenty miles to the south, the Magnesian Limestone is seen, as the author is informed by Mr. G. Fowler, C.E., resting immediately upon the same seam. This so far corroborates the opinion of Mr. Howell, that the axis of the elongated basin in which these Coal-measures probably lie is along a line passing north-west and south-east through Bradford and Worksop. At the same time it removes the Permian rocks, by an enormous space in time, from the Carboniferous Period. This removal is further shown by the examination of a fault at the Cinder Hill Colliery, at Basford. This fault has been found, by actual measurement in the pit, to have effected a displacement in the Coal-measures to the extent of 88 yards of *throw*, while the same fault, passing upwards through the Permian and Bunter rocks, has affected *both these series equally*, but to the extent of only about thirty feet of displacement. The whole fault is therefore the result of *two separate movements;* the first and greatest, Pre-permian; the second subsequent to the deposition of the Lower Bunter.

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[1] Being the substance of a paper read before the Geologists' Association, March 6th. —*Prof. Morris, F.G.S.*, Vice-President, in the Chair.

The recent high prices of coal and the prosperous condition of Nottingham trade have led to many borings for that mineral in the neighbourhood; *e.g.* at Chilwell, and at Highfield, both in the Trent Valley near Nottingham, and at Swinderby near Newark. At Highfield, Coal-measures were entered after passing through nearly 100 ft. of Bunter rock; and Coal has been cut at a depth of 254 ft. That at Swinderby is perhaps the most interesting boring going on anywhere; since, if scientifically conducted, it will throw great light upon the south-easterly extension of the Coal-basin, (which is considered by high authorities to include Newark and Lincoln,) and inferentially upon the physical geography of Carboniferous times—the extension of the old land surface believed to have occupied great part of the present German Ocean. At the colliery of Saul Isaac, Esq., M.P., close by Nottingham, the Top-hard coal is cut at a depth of 70 yards, and the Deep-hard is worked at a depth of 270 yards. The Top-hard seam has been thrown down a distance of 95 yards on the south side of the pit, and is soon to be worked at that extra depth, on account of the great expense which is caused in the working of the Deep-hard seam, by a number of 'step'-faults with a throw of 3 to 5 yards each, on the north side of the pit. The Coal is at present largely worked in the valley of the Leen, at Hucknall, and other places; and even through the Triassic rocks at Annesley. A pit is being also sunk on the north side of Bestwood Park. In this we see a speedy realization of the anticipation, by the late Sir R. I. Murchison, of the time when a general rise in the price of coals would lead to a great extension of the working of the seams; which, as he showed in his paper before the British Association at Nottingham, in 1866, extend a long way to the eastward beneath the Permian and Triassic rocks.

(2). *The Permian.*—The great unconformability between the Coal-measures and the Permian rocks is rendered the more significant by the absence of the Lower Red Sandstone (or Rothliegende). On the other hand, there are clear signs of *continuous deposition* of the Permian and Lower Bunter rocks, as is seen by examination of the sections exposed: (1) at Cinder-hill, (*a*) in the brick-yard, (*b*) in the railway cutting now in progress through the outlier of Bunter resting upon Permian rocks a little more to the North; (2) at Kimberley. The junction of these two (so-called) formations is marked by a band of breccia, the rocks above and below this band being conformable to one another. Moreover, as we pass south, the Permian strata disappear altogether, the Bunter overlapping them and resting immediately upon the Coal-measures.

In the absence of palæontological evidence, what can we rely upon but stratigraphical data? And so far as this area is concerned, the latter seem to point to the Permian and Bunter as but portions *of one great unbroken* sequence of rocks with perhaps a slight alteration of the shore-line at the horizon where the breccia occurs, deposited upon the much disturbed and denuded Coal-measures, and highly unconformable to them. If therefore the Permian must needs be assigned to the Palæozoic epoch, the Bunter, it would seem, ought to go along with it; while a boundary line drawn above the Bunter would be perhaps more natural and more analogous to the line of demarcation between the Mesozoic and Cainozoic epochs. Another way out of the difficulty would be, perhaps, to consider the Permian and Bunter as one great transition series. After a careful perusal of the valuable memoir by Prof. Hull on the *Permian and Triassic Rocks of the Midland Counties*, and thus becoming acquainted with the *meagre evidence* on which the great line of demarcation between the Bunter and Permian rocks has been drawn in the northern Permian area, the author feels compelled to attach some importance to the evidences of continuous deposition which are found in this neighbourhood.

(3). *The Bunter.*—The Lower Mottled Sandstone does not attain a greater known thickness than one hundred feet in the Nottingham and Derbyshire area. Some good sections of it are seen at Basford, Radford, and Lenton. At the last-named place it has been brought up by a fault of more than three hundred feet *throw* to a level with the Keuper. This fault may be observed in the lane close to Highfield; also about a mile to the west, and in the Wilford colliery, where its throw is proved by actual measurement. The "Himlack Stone" on the north side of Bramcote Hill exhibits the junction of the Lower and Middle Bunter. It is marked by unconformability, and a bed of calcareous grit and breccia forms here the basement of the Pebble Beds. This clear boundary-line is by no means general; a passage marked by the gradual appearance of pebbles and hardening of the rock is far more common in the district. This passage may be well seen in several places; as, *e.g.* on Nottingham Forest adjoining the race-course, at Basford, and in the road-cutting about a mile south of Mansfield.

The Middle Bunter is evidently a shore-formation, with thick beds of sandstone, much harder than the Red and Mottled Sandstones above and below. Intercalated bands of distinctly laminated micaceous deep-red sandstone, semi-consolidated gravels, and true conglomerates, containing an immense variety of pebbles (chiefly of quartzite), some well-rounded, others sub-angular, are its chief characteristics. The general prevalence of "oblique lamination" indicates an area of deposit subject to shifting currents, while the great quantity of sand mingled with the pebbles, as contrasted with a shingle thrown up by a rolling surf (as *e.g.* the Chesil Bank at Portland), seems to imply a shore somewhat protected from the open ocean. The cakes and lumps of red and purple marl found in the rock seem to indicate some disturbance of the Permian strata, supposing, as is probable, that they were derived from the Permian marls. The angularity of many of the contained fragments is well preserved, and they appear to have come from different sources *at varying distances*; even slabs of Millstone-grit and Yoredale sandstones, distinctly angular, are to be met with imbedded in the hard sand rock. The Castle rock, which overlooks the Trent, is of this sub-formation, and most of Nottingham is built upon it. The ancient cave-dwellings, which gave the name to the town, are excavated in it. The Castle rock is traversed by a series of 'master-joints,' running in a north-westerly direction; and joints parallel to these are to be observed at intervals all along the southern face of the rock. The valleys formed by the erosion of this rock, and opening upon the Trent Valley, appear to have had their direction determined by these joints, which, as lines of weakness, must have facilitated denudation.

The Upper Red and Mottled Sandstone, which overlies the Pebble beds in some parts of the Triassic area, but is usually considered to be wholly wanting in this district, seems nevertheless to be represented by some fragmentary patches. From a description of one of these, so high an authority as Professor Hull has been led to acquiesce in this view of the author's; but most of it was denuded away in the interval between Bunter and Keuperian times.

The present Bunter country includes the old forest-lands of Sherwood. It offers great advantages for water-supply, its porosity and underlier of marl allowing it to act as a huge reservoir.

(4). *The Keuper.*—The Lower Keuper strata or "Waterstones," consisting of alternating beds of sandstones and marls, are seen, in the few sections where the junction is exposed, resting upon the eroded or denuded surface of the Bunter. Close to Nottingham this has been observed, (1) in Red Lane, (2) in a culvert now covered over on the east side of the town (by Mr. E. Wilson, F.G.S.). At both these places the junction is marked by a bed of highly calcareous breccia, and there is unconformability between the two formations. The junction is also exposed in the hill-side east of Sneinton, where there is a marly breccia; and a still more interesting example of it was to be seen a short time ago in a culvert at the foot of Blue-bell Hill, close to Nottingham. Here the junction is marked by a hard red conglomerate (1 foot thick). This is surmounted by 8 feet of Keuper sandstones, interbedded with three well-marked layers of ochreous-yellow limestone, each about 3 inches thick. May not these be homotaxial with part of the Muschelkalk? Above these the marls and ripple-marked sandstones come in. Some good sections of the Lower Keuper, showing the passage into the Upper Red Marls, may now be seen in the cuttings and tunnel of the railway in course of construction on the north-east of Nottingham. Footprints of *Cheirotherium* have been observed at Castle Donnington, and recently by the author at Colwick, near Nottingham. Rain-pittings, sun-cracks, and ripple-marks are also frequently met with. The latter are so common on the blocks of mudstone brought from beneath the Mapperley Plains as to form the rule rather than the exception.

The Upper Keuper strata are much more marly in character than the Lower. The two members of the formation may be seen side by side, where a fault intersects the face of the cliff that overhangs the

Midland Railway and faces Colwick Hall. The upper series is marked here, as elsewhere, by the comparative absence of sandstones and the abundance of veins of satin-spar or "fibrous gypsum." Here and elsewhere the author has noticed a general tendency of the direction of the long prismatic crystals towards the vertical; a phenomenon as yet unexplained so far as he is aware. Gypsum of a more amorphous character ("alabaster") is largely quarried at Chellaston and Aston (where beds occur 9 feet in thickness), at Thrumpton, and at Newark. At the last-named place the beds are about a foot in thickness, though one bed attains a thickness of three feet, with numerous thin veins ramifying in all directions, quite irrespectively of the planes of bedding of the marl. Rounded and lenticular masses of gypsum (some pure white, others of a delicate flesh-colour) are found here also, and have so contorted the strata above them as to give proof of their consolidation subsequently to the deposit of the marls. Pseudomorphs of rock-salt have been found in the uppermost beds of the marls at Newark, Colwick, Blue-bell Hill, and Carlton, in addition to the places mentioned by the Government Geological Surveyors. The author has in his possession a slab (picked up at Newark by one of his pupils) on which the pseudomorphs are interspersed with fish-scales—precursors, as it were, of the Rhætic bone-bed. The total thickness of the Keuper is little, if any, more than 200 feet.

(5). *The Rhætic Beds.* The black paper-shales were discovered by Mr. Etheridge a short time ago, at Elton, near Nottingham, on the Great Northern Branch line; and the author has found there also a portion of the 'bone-bed.'

A section of Rhætic beds was found by the author last spring outside Newark, where are seen:

	feet.
1. Black 'paper-shales' abounding along a certain horizon in *Avicula contorta* and *Pullastra arenicola*	10
2. Grey and greenish marls	15
	—25

The uppermost zone, or 'White Lias,' is not seen *in situ*, but what appear to be fragments of it are found in the soil above, and, in one place, among a mass of disturbed materials, composed of black shales, much broken up and mingled with pebbles apparently from the Bunter. This mass is probably in one sense a 'boulder-clay.'

Another section of the Rhætic has quite recently been brought to light at 'Spinney Hill' near Leicester, and noted by Mr. J. J. H. Teall, B.A., F.G.S.

(6). *The Lias.*—This formation plays but a subordinate part in the geology of the district, until we get into Leicestershire and the Vale of Belvoir. It caps the hills about Gotham and Thrumpton along the south side of the Trent, where no doubt Rhætic Beds might be discovered by digging into the flank of the hills. Belvoir Castle surmounts an escarpment of Marlstone of the Middle Lias, which abounds there, as in the Banbury district, with *Rhynchonella tetrahedra* and *Terebratula punctata*.

(7). *Drift and Alluvium.*—A great part of the former appears to have been carried down into the valley of the Trent, where extensive gravel-pits are worked, as at Beeston and Sawley. The pebbles and small boulders found in the gravels are very similar to those found in the drift, of which some detached portions may be seen at New Basford, Lenton, Cinder Hill, and Annesley. In these instances the drift lies immediately upon the Bunter Sandstone. They are all in the Leen basin; and supposing them to be of Post-glacial age, they would seem to indicate a comparatively recent date (speaking geologically) for the present valley of that river, which is certainly formed by the erosion of the Bunter, on which the drift lies in elevated positions. The abundance of Bunter pebbles at present scattered over the Permian strata in the Leen Valley affords corroborative evidence of this former extension of the Bunter strata. The age of the Valley of the Trent is not so easily made out. From the occurrence of drift on the higher portions of ground included within its present basin, it would appear that the sculpturing of the main features of the landscape began during or before the Glacial Epoch. Great, however, as is the amount of alluvium and low-level gravel contained in the present valley, there can be little doubt that this is now the redeposited drift, since bones of recent Mammalia have been found in the river valley; notably in the sinking of the Wilford Pit, where they lay at the very bottom of the alluvial deposits, 25 feet below the surface. If, as it has been supposed, the Trent was once a tributary of the Rhine, that will only carry us back (according to Prof. Ramsay) to Miocene times. The question then arises whether the time between that and the Drift period is sufficient to allow for the denudation of the present area of Trent drainage, and the contemporaneous cutting down of the two passages through the Oolite escarpment, one of which is now occupied by the Humber, the other by the Witham at Lincoln.

NOTICES OF MEMOIRS.

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I.—MINERALOGICAL OBSERVATIONS IN THE ARGENTINE REPUBLIC.

Mineralogische Beobachtungen im Gebiete der argentinischen Republik von ALFRED STELZNER. Mit chemischen Beiträgen von MAX SIEWERT. *Mineralogische Mittheilungen,* 1873, Heft iv. pp. 219-254.

IN this paper Dr. Stelzner, of Cordoba, records the results of his mineralogical studies in certain parts of the Argentine Republic. The value of the communication is much increased by the analytical work contributed by Dr. Siewert.

The Sierra of Cordoba, which stretches in a north and south direction over nearly three degrees of latitude, is formed of three parallel ridges, of which the central and most lofty, called the Sierra Alta, rises to a height of about 1200 metres above the surrounding pampas. These mountains consist essentially of crystalline slates, associated with granite and other rocks. The granite is penetrated in many places by quartz-stocks, which are interesting for the sake of the accessory minerals they carry. Although consisting mainly of quartz, they invariably contain mica and large crystals of orthoclase; and *may thus represent* a highly quartziferous variety of pegmatite.

Beryl occurs in fine crystals, in some cases measuring 10 c. m. in diameter and 30 c. m. in length; whilst apatite is found in similar, though much smaller, green crystals. Stelzner has discovered triplite—a phosphate of iron and manganese—in two varieties, the one light and the other dark coloured; the former represents the purer and fresher condition of the mineral. Analyses of both varieties are published by Siewert. The alteration of triplite has given rise to heterosite. Near San Roque Stelzner has discovered the rare mineral Columbite, specimens of which have also been analysed. Some interesting questions are suggested by the paragenesis of the minerals in these quartz-stocks, and their relation to similar occurrences elsewhere.

Alternating with the old crystalline schists of the Sierra are certain zones of crystalline limestone, which have been specially studied by Stelzner. As accessory minerals in these limestones, he mentions quartz, orthoclase, hornblende, magnesia-mica, titanite, garnet, pistacite, coccolite, scapolite, wollastonite, chondrodite, serpentine, ceylanite, calcite, and malachite. The description of these minerals is followed by an interesting discussion of their probable origin, with special reference to the development of mineral silicates in metamorphic limestones.

The third part of Stelzner's paper describes the énargite lodes of the Famatina Mountains. A mineral associated with the enargite is described as a new species under the name of *Famatinite*. From Siewert's analysis it appears to be a combination of the sulphides of copper, antimony, and arsenic; in fact, an antimonial enargite, in which part of the antimony is replaced by arsenic. Its composition may be represented by the following formula: $4(3Cu_2S.\ Sb_2S_5) + (3Cu_2S.\ As_2\ S_5)$.

After describing the occurrence of a number of other minerals, more or less rare, Dr. Stelzner calls attention to certain sandstones exhibiting curious pseudomorphs after rock-salt. Some blocks of this stone have the surface studded with small hemispherical protuberances, believed to be pseudomorphs after a peculiar form of saline efflorescence. The layer of sandstone immediately above this surface would necessarily show pits corresponding with these elevations, and resembling those little hollows which in many sandstones represent rain-drops. Without denying that such impressions may be preserved under peculiarly favourable conditions, Stelzner raises the question whether some of the so-called "fossil rain-drops" may not be merely the concavities corresponding with pseudomorphs after an efflorescence of salt. F. W. R.

2.—UEBER DIE BEDEUTUNG VON TIEFBOHRUNGEN IN DER BERGÖLZONE GALIZIENS. By FR. JULIUS NOTH. *Jahrbuch der k. k. Geologischen Reichsanstalt*, Jahrgang 1873, Band xxiii. No. 1, pp. 1–8, with 2 plates of sections.

THE district in Galicia over which signs of mineral oil occur is said to be sixty miles (German) long, by an average of two to three wide, occupying a great part of the northern branch of the *Carpathian* Mountains.

several shafts, not over 100 feet deep, as much as 3,000
nineral oil have been taken. Volatile gases are a danger in
shafts; a spark struck from the tool will sometimes cause an
n with fatal results, and cause the sinking to be abandoned:
s described as sometimes issuing from the pores of permeable
e with a loud hissing sound. In Middle Galicia, the most
t locality for mineral oil is the neighbourhood of Dukla and
a. Here 150 shafts have been sunk, and the yearly produce
20,000 cwt. The Ropianka oil appears of a dark-green
r by transmitted light brownish-red; its specific gravity is
·83; it contains paraffin. From one bore-hole of about 300
p, as much as 4,000 cwt. were obtained. The American
f rope-boring seems to be much used, but it is said to be
for anything over 500 feet. Different qualities of oil—
in composition—may occur in the same shaft, showing
re must be several sources, met with at different levels it
not in connexion with one another.

lace of largest production in Galicia is Boreslaw, where in
shafts have been sunk, mostly shallow ones, 98 feet to 180
n which 90,000 cwt. of oil and 45,000 cwt. of hydrocarbon
xy consistence have been taken. The total amount raised
a in the last few years is estimated at 300,000 cwt., and its
hen refined, at £300,000. The author recommends that the
ould undertake certain deep borings, as they seem to have
he Coal-districts of Upper Silesia and Bohemia, with results
ourable to the prosperity of large districts. He thinks that
dustry would be very largely increased thereby. At present
e supply is not sufficient for the wants of the population,
rican petroleum is therefore imported. E. B. T.

LOGISCHE DARSTELLUNG DER GEGEND ZWISCHEN CARLSTADT
ATIEN UND DEM NÖRDLICHEN THEIL DES CANALS DER MOR-
. By E. TIETZE. *Jahrbuch der k. k. Geologischen Reichsan-*
Jahrgang 1873, Band xxiii. No. 1, pp. 27–70.

uthor of this report was commissioned to examine the above
trict at the instance of the military authorities in charge of the
who experienced the greatest inconvenience from the great
f water in the district. This sketch does not extend over
le of the "Karst," or that Limestone and Dolomite range
xtends from Carinthia and Istria, through Western Croatia,
, and Albania, to Greece, on the eastern shore of the Adriatic;
als with a small piece of its length, but of the full breadth,
ut of the middle. The Croatian "Karst" is, speaking
a grand saddle in a N.W. and S.E. direction of Triassic
companied with Cretaceous beds on the flanks, and including
inor undulations. Similar petrological character and scarcity
s make it frequently impossible to distinguish the ages of the
Dolomites.

ldest beds in the district are some dark-grey, reddish, or
olomites near *Ogulin;* they are sandy and very tough beds,

and gave much trouble to engineers of tunnels on the railway. They are probably of "Wellenkalk" (Muschelkalk) age. Above these are black limestones, in which no fossils have been found, but which represent probably a higher stage in the Muschelkalk. As far as appearance goes, these are said to be easily mistakable for Lias or certain Cretaceous beds. Other grey or whitish thick limestones, forming the tops of many mountains, and even ranges, are referred to the Upper Trias; there is often a dolomitic breccia at the base of these. The Dolomites on the coast near Zengg have been referred by Stoliczka to the Cretaceous, but by Fœtterle to the Trias. The Foraminifera, which the former thought he had found, are said by Fr. von Hauer to be too dubious. The present author, in the absence of fossils, is unable to decide definitely between the views of his predecessors; but he inclines to consider them Trias. In the neighbourhood of Zengg is some porphyritic Diorite, which may probably be of Triassic age.

The Lias has been known for some length of time to occur near Carlstalt; the fossils from here, determined by Schlœnbach, were Upper Lias forms, *Ammonites bifrons*, etc. No fossils of other Lias horizons have yet been found in this locality.

Other beds, viz. those at the summit of the Stallak and Vinica, have been referred provisionally to the Jurassic, but no fossils have been found in either case.

The Cretaceous beds occur chiefly on the eastern side of the saddle. Near Ogulin were found *Radiolites* abundantly, with *Pecten, Nerinæa*, etc.; again near Carlstalt, small *Caprotinæ*. Petrologically these differ from the Triassic limestones generally in being less tough.

The next higher beds are the Nummulitic—whitish-yellow limestones. Brown and greenish sandstones of the Upper Eocene fill up the middle of the valley, the fruitfulness of which soil is in strong contrast to the barrenness of the surrounding districts.

Near Bribir occurs some Lignite in the latest Tertiary or Quaternary beds. *Mastodon angustidens* (Cuv.), *Tapirus priscus* (Kaup), and *Cervus* sp., were described from here by Hörnes in 1848.

There remains still the characteristic "terra rossa," or red loam, the origin of which has given rise to discussion. Our author is opposed to its being considered a marine formation, and he notices that it does not occur in the sandstone districts—it seems to be connected with the limestone. As yet no fossil remains have been found in it. He connects it with the hollowing out of the caverns, and refers its formation to the latest Tertiary period immediately before the Glacial epoch.

With respect to the hydrographic relations of the district, the case seems simply this:—the limestone is so cut up by clefts and cavities that no rain can give rise to a system of streams, it all disappears through the rock-fissures which communicate below ground. The subterranean erosion must be immense. Near Ogulin the R. Dobra disappears below ground, but further east, near Popovosello, the other side of the mountain, it emerges again into daylight. This is similar to the disappearance of the R. Poik in the Adelsberg cavern

These subterranean rivers are very characteristic of the "Karst" district, being numerous here, though of course they occur elsewhere.

Another feature of the district are the periodical lakes, *e.g.* the Zirkinitz lake. In these cases after prolonged rain, or melting of snow, the plain will be covered with water; this is no mere overflowing, the water does not come off the hills merely,—it comes mostly from below, either directly from clefts or welling up through gravel. Our author explains the rise of water through the damming back of the water from overfilled subterranean channels. The description of the so-called "Doline" corresponds exactly with the "swallow-holes" of N. England; they are said to be very numerous in the Karst.

The great absence of springs of water has caused this district to be called the "stony Arabia of Austria." The inhabitants are mostly obliged to rely on rain water collected in ponds, and sometimes have to drive their cattle three hours to water. The parts covered with luxuriant forest are just as devoid of springs as the rest of the district, so that no mere planting would do any good. Artesian wells are impracticable, owing to the fissured state of the limestone. In fact it is recommended to form proper reservoirs for retaining the rain water, of which there is a good supply, the annual fall being 4·42 cubic feet to the square foot of area on an average. E. B. T.

4.—GEOLOGISCHE UEBERSICHTSKARTE DER ŒSTERREICHISCHUNGARISCHEN MONARCHIE. Blatt 8. SIEBENBURGEN. By FRANZ RITTER VON HAUER. *Jahrbuch der k. k. Geologischen Reichsanstalt,* Jahrgang 1873, Band xxiii. No. 1, pp. 71–115.

THE explanation of Sheet 8 is divided into three parts, the three mountain systems which surround Siebenburgen (Transylvania) being described separately.

1. *The Carpathians.*—Crystalline schists are found in the Bukowina, etc., both micaceous and chloritic, and with quartzites. Some beds that were formerly placed in this category have been shown to be Trias.

Of sedimentary formations the oldest is the Dyas (Permian), consisting of quartz conglomerates and quartzites. These were formerly mapped as Greywacké. Of the Trias the lower division is represented by fossiliferous beds over 2,000 feet thick, and referred to the Werfen shales and Guttenstein Limestone (Muschelkalk). The Upper Trias is represented by various Dolomites and by Red Marble, with *Ammonites Metternichii* and globose species, probably of Hallstadt age, as well as by shales with *Halobia.* The Lower Lias is found near Kronstadt, and contains coal-beds; then come shales with *Belemnites paxillosus;* further the red Adneth beds (Upper Lias) with numerous Ammonites occur.

Of the Oolitic rocks some of the upper stages, viz. beds with fossils similar to those of the Stramberg horizon. Of the Cretaceous several divisons occur. Lower Neocomian, shales and limestones with *Aptychus;* Upper Neocomian; Upper Chalk, and Marls with *Belemnitella mucronata.*

Eruptive rocks occur, melaphyre, porphyrite, etc.

One colour is used for the Carpathian sandstone. It is not attempted to divide it into Cretaceous and Eocene divisions; the Nummulitic beds, however, are separately mapped: the conglomerates connected with the Eocene are described as many thousands of feet thick.

The varieties of Trachytic eruptive rocks of Eocene age seem to be numerous.

2. *The Southern Transylvanian and Banat Mountains.*

The crystalline rocks are represented by mica schist and gneiss, for which one colour is used, hornblende and chlorite schists being frequently intercalated. In one district eruptive quartz-porphyry has broken through these; in one place granite is in contact with Permian strata, at another it contains pieces of sedimentary rock, which seem to be carboniferous, and give a post-carboniferous age to the eruption. Again, Neocomian Limestones have been altered by contact with the granite, showing that the granite is here newer than the Lower Cretaceous beds.

Besides the granite, there are porphyry and tuffs of Cretaceous age, the latter containing Cretaceous plants.

Of sedimentary rocks in this district we have Carboniferous shales, limestones and sandstones, with Crinoids, Corals, and Plants, a coarse conglomerate being at the base. The Permian exists as greywacké with some red shale, and has trap-ashes connected with it. Fossils have been found, the plants indicate the existence of two or three horizons. The Trias may be present, but details are wanting to enable it to be separately mapped. The Lias is an important formation, from the considerable Coal-bed which it bears in the Steyerdorf district. Both Lower and Middle Lias are present.

The sandstone between two of the Coal-beds has yielded a rich fossil flora; the age is probably *Am. planorbis* zone of Lower Lias. Jurassic beds are present, the *A. Murchisonæ* zone of the Inferior Oolite, probably some of the higher zones, and even the Bath Oolite. At Swinitza the Oolites, though rich in Ammonites, are only six feet thick altogether.

The Upper Oolite is represented, but its divisions are not sufficiently worked out. Of the Lower Cretaceous some beds are referred to the L. Neocomian and considered to be the age of the Berrias beds, others to the Aptien, viz. Upper beds at Rossfeld. The Upper Neocomian is also shown by beds with *Rudistes* and *Caprotina.* The Upper Cretaceous is represented by beds of the Gosau type, and by beds with *Exogyra columba* (Cenomanien).

The Eocene occupies a very much smaller area in the Banat than in the other districts east and west of Siebenburgen. The newer Tertiaries are represented in the Schylthal by coal-bearing beds; fossils show them to be of the age of the freshwater Molasse (Miocene). In the neighbourhood of Dobra the Cerithium beds of the Miocene occur.

3. *The Mountains of the Western Transylvania Boundary.*

The crystalline rocks are represented by mica schist, gneiss, and clayslates, the schistose group occupying a larger area by far than the massive crystalline rocks, granites, Diorites, etc.

The eruptive rocks are numerous; red porphyries occur in the Dyas and Trias districts. Lias beds have been altered in one case, here the eruption would be probably of Jurassic age; Augite-porphyry, Melaphyr, and Syenite (the latter eruptive through Lias) occur. The trachytic rocks are present in three groups, viz. Propylite (Dacite and Greenstone Trachyte), Trachyte proper (Andesite), and Rhyolite. Their eruption took place in newer Tertiary times.

Of the sedimentary rocks the Carboniferous are the oldest in this district. The Permian (Dyas) is probably present; the separation between it and the Trias being indistinct. The Muschelkalk is probably represented by limestones and Dolomites, but no fossils have been found. The oldest fossils are those of the Lias, but there are no Coal-beds in Lias beds in this district. Oolitic beds are found—the Cretaceous are largely developed. The Rossfeld beds (L. Neocomian) contain *Amm. cryptoceras*; above the Caprotina limestone, beds with Gosau fossils occur.

The Eocene rocks are thick and cover a large area. Stache has separated them into three groups, viz. Lower Eocene, freshwater mostly, *Chara* seeds, *Paludina*, etc. Middle Eocene, marls with *Nummulina perforata*, limestones with *N. lævigata*, and gypsum-bearing beds. Upper Eocene, includes beds which may be of L. Miocene (Aquitanien) age.

Newer Tertiary beds,—the three stages of the Vienna Tertiaries occur, the Marine, the Sarmatic, and the Congeria beds, but they are not always separately mapped.

The paper ends with a few words on the Transylvania midland district, which is entirely newer Tertiary or Quaternary.—E. B. T.

5.—BRIEF ABSTRACTS.

1.—BEITRAEGE ZUR KENNTNISS FOSSILER BINNENFAUNEN. By THEODOR FUCHS. *Jahrbuch der k. k. Geologischen Reichsanstalt*, Jahrgang 1873, Band xxiii. No. 1, pp. 19–26, with 2 plates of fossils.

IN this paper some new species from the Vienna Tertiaries are described and figured; they are as follows:

From the Congeria Beds.

Melanopsis avellana.
——— *obsoleta.*
——— *Sturii.*
Melania Letochæ.
Cardium Neumayeri.
——— *Karreri.*
——— *pseudo-obsoletum.*
Dreissenomya intermedia.

From the Sarmatic Stage.

Turbo Aningeri.
Melania suturata.
Melania applanata.
Syndosmya sarmatica.

E. B. T.

2.—JONES, Prof. T. R. Flint: its Nature, Character, and Adaptability for Implements. *Reliquiæ Aquitanicæ*, parts xiv., xv., pp. 202, 205. 4to. [1874.]

Flint, *in one condition* or another, is found in most calcareous rocks. It occurs as sheets and as nodules, generally in beds. It is homogeneous and consists of silica, not so pure, however, as is the case with quartz. This silica, once in solution, has been accumulated round sponges, etc., changing some of the surrounding chalk into its own substance.

Flint has yielded fit material for fashioning into tools or weapons, the application of blows and pressure producing sharp flakes, the substance is also capable of being dressed into definite shapes.

The surfaces of broken flints suffer changes from exposure and from moisture, becoming opaque, and often shining when affected by alkaline water.

The note concludes with a list of the chief works relating to the subject. W. W.

3.—Lowe, W. B. Geological Section [Report of]. *Rep. Rugby School of Nat. Hist. Soc. for* 1872, pp. 47-49 (2 plates). [1873.]

Notes the occurrence of the rare *Discina Holdeni* in the Lias at Hillmorton Pits, of bones in various later deposits, and of various other fossils. Gives a section of Drift over Lias at Rugby Pit, and sections of gravel, etc, along a sewer in Hillmorton and Clifton Roads. A detailed account of the section at the Victoria Lime Works to a depth of 72 feet, through Lias clay and stone, is also given in plate vi. W. W.

4.—Salter, J. W. A Catalogue of the Cambrian and Silurian Fossils in the Geological Museum of the University of Cambridge. With a Preface by the Rev. Prof. A. Sedgwick, and a Table of Genera, etc., by Prof. J. Morris. 4to. pp. xlviii. and 204. *Cambridge,* [1873].

The greater part of the long preface is taken up with an account of the Cambro-Silurian controversy, in which Prof. Sedgwick fully states his own views and their history.

This is followed by a Table of the Classification of the Lower Palæozoic rocks according to Sedgwick, Murchison, Jukes, Lyell, Phillips, and the Geological Survey. Prof. Morris contributes a summary of the contents of the Catalogue, and a Table of the Range of the Genera.

The Catalogue is illustrated by woodcuts and arranged stratigraphically, beginning with the lowest beds. An elaborate geological map (woodcut) of Portmadoc Estuary, with a multitude of faults, is given at p. 9. There are many paragraphs on the stratigraphical relations of the beds, etc. W. W.

REVIEWS.

I.—Geognostische Karte der Umgegend von Heidelberg. Bearbeitet von Dr. E. W. Benecke und Dr. E. C. Cohen. Blatt II. Sinsheim. Strassburg: Karl J. Trübner, 1874.

THIS second part of a very elaborate map of the geological features of that portion of the Grand-Duchy of Baden which lies to traveller's immediate left hand during a railway journey from

Heidelberg to Carlsruhe has just been issued by Dr. Benecke and Dr. Cohen. The district examined stretches as far south as Stettfeld, and as far east along the Mosbach road as Waibstadt, and includes the neighbourhood of Sinsheim and a considerable portion of the valley of the river Elsenz. Deposits ranging from the Bunter Sandstein and the several divisions of the Muschelkalk up to the Loess, not to mention eruptive beds of nephelinite, are given in colour; and the use of the map for field-work is greatly enhanced by the introduction of contour lines faintly marked with red. "Blatt I.," which will embrace the town of Heidelberg and the area immediately north, is to appear next year, and will be accompanied by an explanatory text. It would perhaps still further increase the usefulness of a very excellent map if deposits which have been turned to economic purposes were also indicated. We have been led to make this remark, as we find, for example, at Altwiesloch, no mention of the beds of zinc ore which occur there. Mr. Karl Trübner's Geological Map will doubtless prove very acceptable to the numerous students in the ancient University of Heidelberg and elsewhere.

II.—MANUALS OF ELEMENTARY SCIENCE. GEOLOGY. By T. G. BONNEY, M.A., F.G.S., etc. Foolscap 8vo., pp. 128. Illustrated. (London: Society for Promoting Christian Knowledge.)

THE above is one of a series of Elementary Manuals now being published by the Society for Promoting Christian Knowledge, and is intended by the author to serve as an introduction to the more advanced text-books on the science.

The principal features of the work are, first, a description of the chemical composition, etc., of the various rocks and minerals. Secondly, the modes of operation of the various agents producing changes of the earth's surface, which are treated of at some length and in an admirable manner. And, finally, a brief description, condensed into three chapters, of the various sedimentary rocks in chronological order, commencing with the oldest. With each series is also given its locality, extent, character, and "Life History." Mr. Bonney's style of writing is simple and popular, and, we should think, would certainly be "intelligible to any fairly educated boy or girl of fifteen." So that the book forms a convenient stepping-stone between the little "Science Primer" by Prof. Geikie (mentioned in a previous Number) and the more advanced works on Geology.

The "*get-up*" of the work in other respects, as compared with that of the "Science Primer," is poor. Though the type is clear, the paper is inferior; and some of the woodcuts have a worn-out and old-fashioned aspect, thereby greatly detracting from the value of the book, and giving the impression that the publishers had an eye to economy. We trust they will spend a little more in illustrating the next edition, and also the remainder of the set, for without good figures works of this kind are useless for teaching purposes.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.

April 15th, 1874.—John Evans, Esq., F.R.S., President, in the Chair. The following communications were read:—

1. "About Polar Glaciation." By J. F. Campbell, Esq., F.G.S.

The author commenced by referring to a reported statement of Prof. Agassiz, to the effect that he supposed the northern hemisphere to have been covered in glacial times from the pole to the equator by a solid cap of ice. He described his observations made during 33 years, and especially those of last summer, when he travelled from England past the North Cape to Archangel, and thence by land to the Caucasus, Crimea, Greece, and the South of Europe. His principal results were as follows:—In advancing southwards through Russia a range of low drift hills occurs about 60° N. lat., which may perhaps form part of a circular terminal moraine left by a retreating polar ice-cap; large grooved and polished stones of northern origin reach 55° N. lat. at Nijni Novgorod, but further east and south no such stones could be seen. The highest drift beds along the whole course of the Volga seem to have been arranged by water moving southwards. In America northern boulders are lost about 39°, in Germany about 55°, and in Eastern Russia about 56° N. lat., where the trains end and fine gravel and sand cover the solid rocks. Ice-action, in the form either of glaciers or of icebergs, is necessary to account for the transport of large stones over the plains, and the action of moving water to account for drift carried further south. There are no indications of a continuous solid ice-cap flowing southward over plains in Europe and America to, or nearly to, the Equator; but a great deal was to be found on shore to prove ancient ocean circulation of equatorial and polar currents, like those which now move in the Atlantic, and much to prove the former existence of very large local ice-systems in places where no glaciers now exist.

DISCUSSION.—Mr. Belt stated that he had been over much of the same ground as the author, but had come to quite opposite conclusions. He agreed with Mr. Campbell that boulders only come down to a certain point, but he considered that the very plains themselves are proofs of glacial action. He thought that the absence of boulders is only a proof that there was no chain behind which could supply the requisite rock, and in this case the only signs of the existence of a Polar ice-cap would be due to the blocking up of the drainage by it, resulting in the formation of the plains of Siberia.

Prof. Ramsay thought that the ideas put forward by the author were in accordance with those of previous writers, but he considered that he exaggerated the power of ice in the shape of icebergs to effect changes. The question was whether there were ice-caps moving towards the equator, or whether the configuration of the mountain regions might have produced the observed effects. He expressed himself satisfied that the present configuration would account, at least to a great extent, for the changes which have taken place. The boulders found on the great plain of Russia might have been conveyed either directly by glaciers, or by icebergs broken off the ice-cap itself. Boulders have been seen 40 miles north of the Caucasus, proving the existence there of great ancient glaciers. The absence of boulders on the plains of Siberia was, he thought, to be accounted for by the absence to the north of Siberia of high land from which such boulders could be carried.

Mr. Drew thought that sufficient consideration had not been given to the relative levels of the old and new glaciers. In Cashmere he had observed a difference of *5000–6000 feet.*

Prof. Hughes thought that the theory of ice-caps spreading in both hemispheres from the poles to near the equator hardly deserved discussion, seeing that no facts which could not be otherwise explained had been adduced in support of it, whilst it involved great physical difficulties, and was quite inconsistent with the continuity of the forms of life from pre- to postglacial times. The question before them seemed to be whether a smaller general drifting from northern circumpolar regions, either of land- or floating-ice, would better account for the phenomena observed by the author than a dispersion of boulder-bearing ice in all directions from local centres, especially in the case before them from North Scandinavia. He always understood that the borders of N. Germany and W. Russia could be traced to that mountain-district, and that there was proof that the ice travelled to the north as well as to the south. Unless, therefore, the author showed that some of the boulders could have been derived only from circumpolar regions, he could not see the necessity of calling in anything more than changes of level of various parts of the northern hemisphere along well-known lines of elevation and depression to explain all the phenomena observed. He questioned the accuracy of the view that glacial conditions prevailed at the same time over the whole of even one hemisphere; and referring to the observations of Mr. Drew, pointed out that if the glaciers of any mountain-region were shown to have once descended 3000 to 6000 feet lower than the present ice-foot, it was only necessary to raise that chain 3000 to 6000 feet to make the glaciers descend to their ancient level again.

Mr. Whitaker thought that the broad points of the paper had been lost sight of. The rounded configuration of rocks in Norway he regarded as clearly of glacial origin, but as the effect rather of a great extension of glaciers than of a true polar ice-cap. In Britain the glacial drift towards its southern limit is almost wholly marine, and certainly not due to the action of land-ice, so that it is distinctly opposed to the notion of the southern extension of the ice-cap. He could not believe in the existence of such a cap extending as far as the equator.

Mr. Topley thought that Mr. Campbell's views as to permanent areas of glaciation and non-glaciation due to cold and warm currents did not suffice to explain the facts; nor did he think that a warm current could have passed over the plains of Russia. He remarked that there is no drift in the South of Europe, and that a line running nearly in the latitude of Dover would mark the southern limit of the drift.

Mr. Prestwich said that he admired Mr. Campbell's paper, and recognized that the difficulty in this case lay in determining the boundary between the action of land- and sea-ice. He thought that the existence of a Gulf-stream traversing Eastern Europe was not proved. In the eastern counties of Great Britain there is evidence of submergence in Glacial times, and marine drifts also exist in Brittany. If Northern France were submerged, ingress might be afforded to warmer water.

Mr. Blanford considered that the difference in the faunas of the Black Sea and of the Caspian was so great as to furnish a strong objection to there having been a branch of the Gulf-stream passing on towards Siberia at so late a geological period, as this must have brought about a closer resemblance between the faunas. He objected to blocks found at a considerable distance from mountains being regarded as true ice-borne boulders unless they were striated or polished, seeing that blocks three or four feet in diameter might be seen in Persia, which had been carried five miles or more by the water of insignificant streams. In Persia the country, although greatly elevated above the sea-level, is covered with drift, but there are no signs of striation on the pebbles. In Central Asia, again, long ranges of from 5000 to 6000 feet high show no glacial markings. In his opinion the ice-sheets were entirely local.

The President remarked that the question of glaciation has always been a puzzle. He thought that the notion of great ice-caps covering the northern and southern hemispheres could not be maintained, since it involved the destruction and new creation of the entire fauna and flora. If the boulders referred to by Mr. Campbell were of northern origin, there must have been a flow of water from north to south. It seemed to him difficult to conceive how a current from the Atlantic could have passed over the high lands of Greece. He thought the question as to the glaciation of the Caucasus of much interest. It is difficult to conceive how so vast a denudation as that described could have occurred without either heavy rains or glaciers, but no rains occur there at present. An alteration of level would affect the temperature.

Mr. Campbell, in reply, stated that he had seen it given as Prof. Agassiz's opinion that the ice-caps had *extinguished* all life. He remarked that the boulders have *travelled at least 500 miles from* their original bed over level ground.

2. "Note regarding the Occurrence of Jade in the Karakash Valley, on the southern borders of Turkestan." By Dr. Ferdinand Stoliczka, F.G.S., Naturalist attached to the Yarkund Mission.

In this paper the author described the jade-mines on the right bank of the Karakash river formerly worked by the Chinese. There are about 120 holes in the side of the hill, and these at a little distance look like pigeon-holes. The rocks are a thin-bedded, rather sandy syenitic gneiss, mica- and hornblende-schists, traversed by veins of a white mineral, apparently zeolitic, which in turn are traversed by veins of jade.

Discussion.—Mr. Topley stated that a good description of these quarries had appeared in "Macmillan's Magazine."

Mr. Rudler said that they had also been described in a German periodical.

The President remarked that in the account of the mission to Yunan jade was said to occur in rolled blocks in river-beds, and not to be found *in situ*.

Geologists' Association.

I.—Visit to the British Museum, March 24.—The members, headed by Prof. Morris, proceeded to the Mineralogical Department, where they were received by Prof. Maskelyne, who described a portion of the collection under his charge. The learned Professor directed the attention of the party principally to the Rock-forming minerals. Free Silica, under the various forms of Rock-crystal, Quartz, Opal, etc., was first touched upon, and the splendid series of crystals belonging to this group brought under the notice of the party. The earthy Carbonates were next noticed and described; and the Professor, after directing attention to the Hornblende and Augite series, concluded a most interesting address, in the course of which he took the opportunity of impressing upon members the great similarity, yet important differences existing between these two groups of minerals.

II.—Excursion to Oxford, Easter Monday, 6th April, and following day.—The party, consisting of numerous members from the metropolis, and several from different parts of England, met in the new University Museum at noon. They were there most cordially received by Prof. Phillips, who at once proceeded to announce the programme of the day's work. This was—A preliminary sketch in the lecture-room, by the Professor, of the Geology of the Middle Oolites as developed in the neighbourhood of Oxford. Demonstration by the Professor of the Local Collection in the Museum, illustrating the above. Lunch at the Professor's private residence. A walk to Shotover, under the guidance of Mr. Parker. Tea and conversazione at the Professor's private residence in the evening. In the course of his remarks, Prof. Phillips pointed out the character of the low-level gravels in the valleys of the district, their composition mainly Oolitic, with some admixture of quartzites, felstones, and grits; elephants' teeth abundant. The Oxford-clay in the neighbourhood of the city 600 feet thick. Towards the upper part of the formation, at the brick-yards of St. Clements, *Am. vertebralis* is an abundant fossil. The valley of the Cherwell is cut down to this clay. On ascending the flanks of the valley, it is succeeded by seventy feet of calcareous grit, a loose [illegible] rock in parts cemented by carbonate of lime. Fifty feet of [illegible] Oolite succeeds, rich in corals and shells. From the position in which these masses are now found, it is not probable that they represent actual coral reefs, such as are at present growing in the Indian and Pacific Oceans, but rather that they are the results of drifted masses, like the Bermuda reefs, partially grown over by other corals, and full of shells. About one hundred feet of Kimmeridge-clay rests on the water-worn surface of the last formation. It is tolerably uniform in its composition; and produces fine Selenite crystals, especially in its lower parts. The upper beds are the most fossiliferous, and abound with the remains of Saurians; *Ostrea deltoidea* the most characteristic fossil. Sandy beds of Portlandian age succeed, and the whole is capped by an Ironsand series of Wealden age, about eighty feet in thickness. The party had an opportunity, under the guidance of Mr. Parker, of verifying the above remarks, by actual inspection of the numerous pits and quarries between Oxford, Shotover, and Heddington.

On the following day an early start was made. Prof. Phillips conducted the party to Charlbury, and was ably assisted by Mr. Parker, who served out to each member a lithographic map of the valley of the Evenlode, drawn and geologically coloured by himself.

From Charlbury on the West to Handborough on the East, a distance of about seven miles, there occur the following formations, commencing from the West:

	feet	
		Stonesfield Slate.
Marlstone	16	Great Oolite.
Upper Lias	10	Forest Marble.
Inferior Oolite	12	Cornbrash.

Walking back from Charlbury along the line, the party entered a cutting of Inferior Oolite, and the members immediately proceeded to hunt for fossils. The Oolite here is a pale yellow Ragstone, containing a fair number of shells belonging to the Clypeus grit, which is probably the topmost member of the Parkinsoni zone. Opposite Fauler the Marlstone is being excavated for Ironstone. Here there is a fine section, exhibiting the Marlstone, Upper Lias, and Inferior Oolite, one above the other, in the most striking contrast. The whole section cannot exceed forty feet, and this is all that represents beds, which, at Cheltenham, attain a thickness of more than six hundred feet. The Upper Lias consists of blue sandy clays (not obviously fossiliferous), and on this rests the yellow rubbly Inferior Oolite. A remarkable feature here is a thin bed of rolled shells and pseudo-pebbles, resembling the Dogger of the Yorkshire coast. Instead however of *Terebratula trilineata,* the chief shell here is *Rhynchonella tetrahedra.*

The party now bid farewell to Prof. Phillips, who found it necessary to return,[1] and proceeded towards Stonesfield under the guidance of Mr. Parker. Piles of dëbris, the result of ages of mining for "Slate," are here seen to cover the hill-side. Several good things were obtained by members of the party. The most common shells appear to be *Trigonia impressa* and *Gervillia acuta,* generally small. Traversing the Great Oolite and Forest Marble, the party returned by way of Handborough to Oxford.

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[1] *This was his last farewell to the* Association, he died on the 24th April. See *Geol. Mag. for May, page 240.*

CORRESPONDENCE.

NATURE OF VOLCANIC HEAT.

Sir,—In reference to Mr. Scrope's letter in the Geological Magazine for May, 1874, p. 237, I must exonerate myself from that gentleman's charge of "persistently continuing to saddle him with the advocacy of one or both theories as to the origin of volcanic heat, viz. a liquid nucleus and thin crust, or Hopkins's fiery lakes."

An author's notions are usually gathered from his acknowledged systematic works, and not from scattered magazine articles. I am much mistaken if Mr. Scrope has not throughout his systematic works adopted one or both of the above theories. On reference to the articles in your Magazine from Mr. Scrope's pen, referred to by you in your foot-note (Geological Magazine, March, 1874, p. 127), as modifying or repudiating the above theories, I am compelled to repeat what I have already stated in your April Number, that nothing contained in them appears to me to justify the statement made by you that I "misapprehended,"[1] and now by Mr. Scrope himself, that I have misrepresented him.

Whether Mr. Scrope's subterraneous reservoirs be left as unexplained as to their origin, as Hopkins left his lakes, or be assumed to be derived from a rise in geothermal temperature produced by deposition of sediment, makes no difference as respects the validity of the objections which I have urged as equally applicable to both. No body can raise the temperature of another by conductive transference of part of its heat to a temperature as high as its own. If, therefore, the subcortical matter of our globe, as Mr. Scrope terms it, "passes locally under varying conditions of heat and pressure" . . . "to a liquid or even vaporous state," there must be matter more deeply situated at a still higher temperature, *i.e.* there must be a liquid nucleus. Things as essentially different and distinct as are the views which I have enunciated as to the nature and origin of volcanic heat and energy from those anywhere enunciated by Mr. Scrope, may easily be made obscure or confused by fragmentary controversy. I must therefore decline to go further in this direction. I have reduced my own views as to the nature and origin of volcanic heat to the brief and unmistakable form of a definition (Phil. Trans. 1873, vol. i. para. 67, p. 167). Every clear-cut thought and theory can be reduced to the same form. That neither I nor your readers may mistake further (if I have already done so at all) Mr. Scrope's views, will he be good enough to reduce them to a definition? Definitions do not involve any dogmatism, and are extremely serviceable in preventing misconceptions, whether arising from obscurity of expression or of thought.

15th May, 1874. Robert Mallet.

A PROPOSAL FOR A SWISS GEOLOGICAL RAMBLE.

Sir,—I beg leave to draw the attention of the readers of the Geological Magazine to a proposed Swiss tour, which might be a very delightful and instructive holiday, and certainly a less expensive trip than one of equal length in dear (very dear) old England or Scotland.

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[1] *We are content* to refer the impartial reader to the articles in question and to *'oulett-Scrope's* published works.—Edit. Geol. Mag.

But first I must briefly explain my connexion with the plan. Often, very often, I have fervently wished, during my excursions in the Alps, that a Swiss man of science could have been with me to explain the wonderful geological phenomena surrounding me, instead of having slowly to work out so much as there was time to unravel, with books (of course left in the valley) as my only assistants.

I therefore mentioned amongst my friends how charming it would be to make up a party and secure the kind assistance of an enthusiastic geologist possessed of familiar knowledge of the localities we should visit.

Many friends fell in with the idea, and asked me to take charge of the party and to occupy the place of the ideal geologist, for whose presence I have so often wished.

Now with regard to the guidance of the party, I have willingly accepted the part of organizer, for a climber paying his eighteenth or nineteenth visit cannot be very ignorant of mountain or valley. And I could so far fulfil the geologist's function as to sketch out the nature of what is known of such points as I have visited. But I entirely decline encroaching upon the functions of a thorough Alpine geologist, without whose aid our trip would lose half its charm.

The season being far advanced, it is I fear too late to form a party for this summer; but if you will allow some space for discussion of details in the GEOLOGICAL MAGAZINE, I have no doubt whatever that in 1875 a most effective party could be made up, to include Botanists, Mineralogists, and Entomologists; and I may mention that if only twenty joined together, with circular tickets, a courier could be sent with them, free of expense, to make all hotel and other arrangements—a great saving of anxiety in the tourist season.

Two modes of joining our trip might be adopted: one, to make the whole round decided upon together—by far the most luxurious plan; the other, that persons not wishing to travel with a party should rendezvous with the rest at certain important places. A long experience of travel and many figures now before me enable me to say that, with first-class fares, hotel living, and all reasonable luxuries, the personal expense need not exceed one pound per day for one month, and that for a number it *might* be a trifle less; whilst strictly economical travellers could well reduce their disbursements.

I will beg such of your readers as may fall in with my hobby, ladies as well as gentlemen, to communicate with me, not, however, with a view to this year's operation. If I act at all in such a matter, it must be with time enough to make the most effective arrangements I can invent, and to communicate with many persons abroad.

In conclusion, let me ask the President of the Geologists' Association what he would think of this extended excursion? I need say no more.

SCIENTIFIC CLUB, 7, SAVILE ROW, W. **MARSHALL HALL.**
June 13th, 1874.

GLACIATION OF WEST SOMERSET.

SIR,—In the article under the above heading in your last Number, Mr. Lucy does not seem to be aware that the grooves on the banks of the Exe, supposed by Professor Jukes to be ice-marks, were afterwards clearly shown by Mr. Whitley to be a development of rock-structure by weathering (Quart. Journ. Geol. Soc., vol. xxiv. p. 3). In West Somerset there is a greater display of curved-back slaty laminæ than anywhere else in South Britain; and in endeavouring to account for the phenomena, I mentioned land-ice as one of several competing agencies in an article in the above Journal for November, 1867. The direction of the curvature is from about N.N.W. to S.S.E., and great blocks of quartz imbedded in angular drift have been transported in the same direction. The curvature may be well seen on the flat summit of Brendon Hill, and must have been produced by some cause assailing the high ground of West Somerset from the N.N.W., and not moving down the hill-slopes towards the north. Though not in any way doubting the validity of Mr. Lucy's discovery of ice-marks near Ashley Lodge, I may state that during several years' successive residences in different parts of the south-west of England, I never once saw any *certain* trace of the action of land-ice, nor have I seen such trace anywhere in England to the S.E. of a line drawn from about the mouth of the Tees, by Ilkley, to Hope Mountain (on the east side of which there is an extensively rounded and strikingly striated rock-surface), near Wrexham. Mr. Croll, in your last Number, does not seem to be aware of the existence of a beautifully-planed, polished, and striated rock-surface on the north cliff-line of Rombald's Moor, west of the headland called the Calf, near Ilkley. When I saw it in course of being exposed by the quarrymen, I was under the impression that it had been produced by an iceberg (see Proc. of Geol. Soc. of West Riding for 1870); but I now believe that it was caused by land-ice, and that it approximately marks the S.E. boundary or sea-wall of an ice-sheet which never extended any farther. Professor Ramsay believes that the apparent ice-marks on the Bloody Stone near Matlock (discovered by me, and afterwards described by Mr. A. H. Green, and the Rev. J. M. Mello), are not reliable.

Mr. Lucy refers to Boulder-clay and Gravel in West Somerset. For several years I devoted attention to the drifts of many parts of the South and South-west of England, but refrained from publishing much on the subject[1] until I had examined the Glacial drifts of the North-west of England and North Wales. I now believe that comparatively little progress will be made in arriving at certainty concerning the sequence of events during the Glacial period in South Britain, until some geologist has given several years' undivided attention to the task of correlating the Glacial drifts of the North with the non-Glacial drifts of the South, that is, the drifts which contain truly glaciated stones in a matrix ground up by ice, with the drifts in which no certain trace of either the one or the other can be detected. The task could only be accomplished by one person making a detailed survey of all the superficial accumulations lying in a line (say) from Plymouth to Carlisle, and the ground would have to be traversed to-and-fro, as the drifts of one district have been found to throw much light on those of another. One great and fundamental question to be solved would be the age of the "Head" relatively to that of the Pinnel of the Lake District. The former overlies the raised beaches of the South-west of England.

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[1] See GEOL. MAG. Vol. IV. p. 390.

D. Mackintosh.

GLACIATION OF THE SOUTH-WEST OF ENGLAND.

Sir,—The subject of the Glaciation of the South of England is gaining more and more attention, and Mr. Lucy's observations in West Somerset, as recorded in the June Number of your Magazine, will be read with interest, particularly in reference to the identification of glacial striæ on a mass of sandstone near Porlock. In regard to the gravelly deposits in the lowlands near Minehead, I was led, during a short excursion to the neighbourhood in the Spring, to assign to them an alluvial, or possibly estuarine, origin; at the same time it is not unlikely that the gravels on the high grounds, as those in the neighbourhood of Tiverton, may be of glacial derivation. Mr. Poole has recorded the occurrence of tusks and teeth of the Mammoth in a deposit of clay and gravel at St. Audries, and he remarked that "originally the whole skull was there."

On my return a few days since from a short holiday trip in Norfolk to the Black Down hills in Devonshire, I was conducted by my colleague, Mr. Ussher, F.G.S., to see some "rum stuff" on the high ground between Little Down and Manning's Common, about two miles N.N.E. of Yarcombe, and between Honiton and Chard. Here the surface of the ground is of a clayey nature, and the formation beneath is the Greensand. Mr. Ussher pointed out one or two places where pits had been sunk for marl, and the presumption was that there was a trace of chalk not noticed in the previous survey of the district. On careful examination we found traces of chalky and chloritic marl and true chalk (one piece contained a small fish tooth), but the whole deposit was interbedded with clay. The clayey and sandy deposit, which covered the surface of the ground adjoining to the depth of eight or ten feet, contained numerous large and well-worn boulders of Greensand chert, large pebbles of quartz (one to three inches in diameter), numerous small pebbles of quartz, rolled flints, and a few smooth and good-sized boulders of quartzite. There were also a few pellets of Chalk, besides traces of Fuller's Earth, and nodules of "Race." A pit recently opened showed about seven feet of greenish-yellow carbonaceous clay with a seam of gravel, resting upon an irregular surface of coarse reddish-brown and pale-coloured sand. The nature of these deposits led me to class them as Boulder-clay, and as such they seemed to possess more than merely local significance.

The great deposits of flint and chert found on the summits of the Greensand hills of Dorset and Devon have been noticed by De la

Beche. Buckland,[1] and others, but their origin has never been clearly explained. Much material, no doubt, is due to the disintegration of the Chalk *in situ*, in helping to form a sort of "Clay-with-flints," which is everywhere conspicuous on the Chalk hills, and in some cases where the Chalk has been entirely removed, the flints have become mixed with the disintegrated chert of the Greensand. This, too, as Mr. Whitaker has pointed out, is partly due to the attenuation of the Lower Chalk and the consequent nearness of the Upper Chalk with flints to the Greensand. The Greensand itself has been partly broken up by the action of the weather, and partly by the not-to-be-overlooked action of the plough. There is still, however, much to account for in the amount of chert detritus, and also in the occurrence of quartz pebbles. The smaller quartz pebbles may be derived from the "Chalk with quartz grains" at the base of the Chalk series, described by De la Beche, but the larger ones have not been so locally derived.

When we look to this probable Boulder-clay near Yarcombe, we may admit an agency which will account for the dispersion and wearing of the superficial deposits now found on the hills, and which certainly can no more be attributed entirely to atmospheric agencies in action in the area, than to river action. It seems rather premature at present to call in the agency of a "South of England Ice Sheet," as might be inferred, perhaps, from Mr. Croll's patient investigations, and I should prefer attributing the formation of the deposits to marine agency during the Glacial-submergence, with the assistance of an occasional iceberg. However, until the country is worked out in detail, it is not well to theorize further.

Horace B. Woodward.

Stockland, near Honiton,
10*th June*, 1874.

P.S.—June 25th—Subsequent investigations have confirmed my opinion as to this Boulder-clay. Deposits similar to those at Little Down, have been found by Mr. Ussher and myself between White Staunton and Howley, and in other localities in this district. H.B.W.

The Sandwell Park Trial Sinking.—The success of this important sinking having now been fully achieved by the finding of the *thick coal* at a depth of 418 yards, and of a thickness 20 feet 6 inches, it is proposed to furnish some account of the fossils met with and the general character of the Red rocks passed through before reaching the reputed Coal-measures. Prof. Ramsay, LL.D., F.R.S., Mr. Carruthers, F.R.S., and the Editors of the Geological Magazine, will take part in the proposed work, which will be brought out under the patronage of the Right Hon. the Earl of Dartmouth, upon whose estate the sinking has taken place. Further particulars will shortly be published by Mr. Henry Johnson, the Engineer and Secretary of the Company, Trindle-road, Dudley. The shares of the Company are now worth a thousand guineas each, with one hundred guineas paid up.

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[1] Dr. Buckland noticed the presence of Grey wethers—"Siliceous breccia, like [illegible]hire puddingstone"—at Sidmouth and Black Down. Trans. Geol. Soc., [illegible] *vol. ii. p.* 126.

Fig. 2.

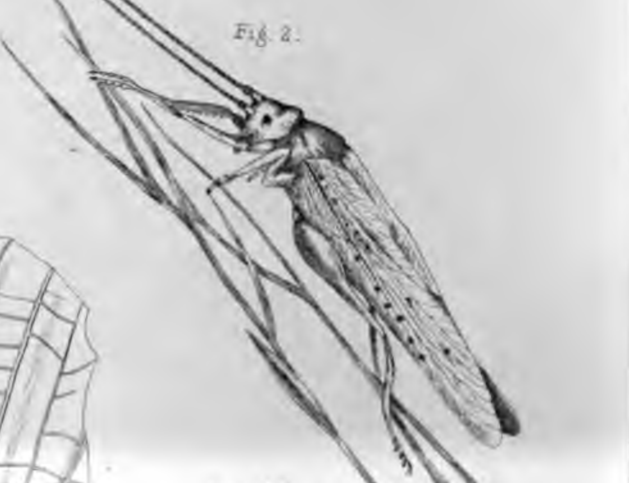


Fig. 3.

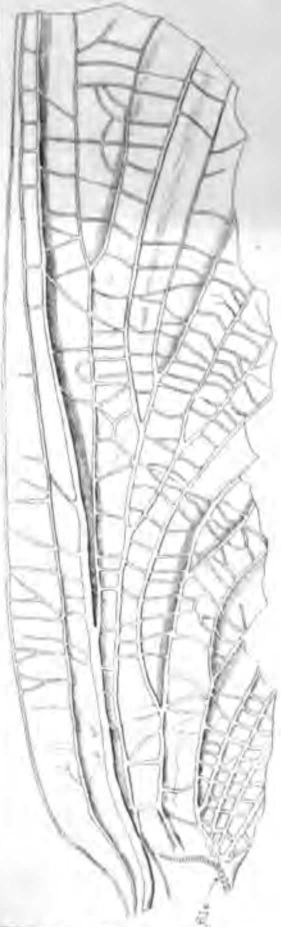


Fig. 1.

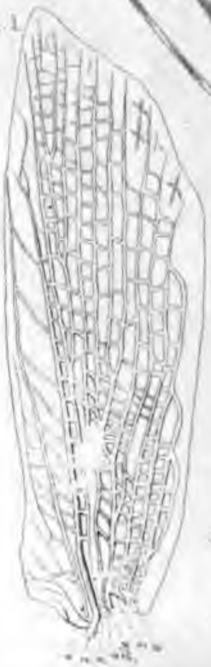
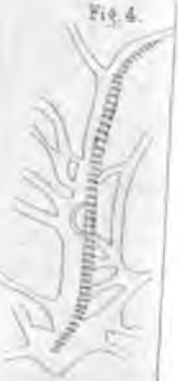


Fig. 4.



[illegible] 230, Holborn.

Fossil Orthoptera.

THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE II. VOL. I.

No. VIII.—AUGUST, 1874.

ORIGINAL ARTICLES.

I.—NOTES ON CERTAIN FOSSIL ORTHOPTERA CLAIMING AFFINITY WITH THE GENUS *GRYLLACRIS.*

By A. H. SWINTON, Esq.

(PLATE XIV.)

Eocene Tertiary ...	1. *Gryllacris Ungeri*, Heer. Figured and described by Heer in his Insectenfauna, 1849, s. 8, t. i. 2. *Gryllacris Charpentieri*, Heer, op. cit. s. 12, t. i.
Coal Formation ...	3. *Gryllacris lithanthraca*, 2 species. Figured and described in Palæontographica, bd. iv. p. 25 and 28, t. iv. 1–2. 4. *Corydalis Brongniarti*, Aud. Buckland, vol. ii. p. 77.

The above five insect remains, claiming affinity with the modern genus *Gryllacris*, of the order Orthoptera, retain for the investigator no characters in common, but such as may be afforded by the central portion of the principal disk or internomediate field of the elytron, and by the lesser marginal field. From comparison of these areas in the specimens from the Coal-measures, as regards configuration and venation, a certain similarity of design is observed, and a general correspondence detected. By taking Heer's descriptions and figures as data, this character is seen to be reproduced—less markedly distinct from the type observable in certain species of the modern genus of Burmeister—both in the profile of *G. Ungeri* and in other fragments preserved to us in the Eocene strata of the Continent. Complete identification of these species must be the reward of future investigators.

The most perfectly preserved venation is presented by the fragment of *C. Brongniarti*, hitherto reputed a Neuropterous insect, closely allied to the living *Corydalis* of Carolina, and exhibited as such by Audouin at the meeting of the Naturforscher at Bonn in the month of September, 1835, but which Heer seems rather to indicate as belonging to the Orthoptera; and this latter view, it will I think be seen, is quite agreeable to the venation and peculiarities of construction exhibited in its wing, an object of undoubted beauty, revealed by the fortuitous fracture of a nodule of Clay-ironstone, and now preserved in the British Museum. The history of this specimen is somewhat wrapt in obscurity. It was purchased by Mantell at the sale of Parkinson's collection, the latter, there is reason to suppose, having obtained it from the neighbourhood of Colebrook-dale. It was subsequently transmitted to M. Brongniart, and has been described by Audouin (Buckland, Geology and Mineralogy, vol. ii. p. 77). In the Museum specimen of G. Ungeri the wing venation is in some measure preserved, but is somewhat difficult to trace. The figure of it given by Heer, having been obtained from the obverse of the impression, which retains the left elytron intact, gives a little more of the cross venation. The *G. Charpentieri*, figured by Heer, is by no means a perfect exposition of this specimen.

GRYLLACRIS (recent species). Under side of right elytron, see Plate XIV. Fig. 1.

The species of *Gryllacris* are intermediate in character between the crickets and swamp-loving leaf-crickets, the *Locustina* of German authors, of which the great green grasshopper (*L. viridissima*), so partial to our potato fields, is a familiar example. Their haunt is the banks of the warm streams of India or Brazil. MacLeay, on recording his capture of a specimen in such a situation in Australia, remarked a mimicry in these insects to the Neuroptera. Their enormous antennæ, more than twice the length of the wing-covers, are probably a protection. They carry their elytra folded in a way peculiar to themselves. Thus while in the crickets we find the marginal field of the elytron turned down at a right angle to the remaining portion, and in the leaf-crickets the marginal and internomediate fields giving a character to the insect by their roof-shaped attitude, in *Gryllacris* the marginal field brings the internomediate over with it as far as the line described by the internomediate vein, and causes the elytra to present a rounded or somewhat hexagonal superficies at their base, in the position of repose, so that the wing-covers are more inclined than those of the crickets, and less inclined than in the leaf or tree-crickets.

Figure 1 gives the notation of the veins on the system adopted by Heer, which admits also of tabulation, thus :—

Mediastinal vein (unimportant)	Marginal field.
1 and 2. Scapular vein (bifurcate)	Internomediate field.
3. Externomediate vein	
4. Internomediate vein	
5 and 6. Anal vein (this vein presents two stems) ...	Anal field.

Having analyzed a tolerably complex form of elytron as to vein branches, and noticed the primal character afforded by its folding to constitute a case or cover for the hind wings, the task of examining the character of fossilized elytra that may seem to have affinity with those of *Gryllacris* will be in some measure facilitated.

Gryllacris Ungeri (restored). See Plate XIV. Fig. 2.

As the remains of examples of this genus from the Eocene strata are fully described by Heer in his Insectenfauna, I will content myself with some observations on the interesting profile of *G. Ungeri* in the British Museum, of which Fig. 2 is an attempted restoration.

In this case we have the thorax, abdomen, head, antennæ, wings, legs, tarsi, claws, etc., of a probably extinct insect of the Saltatorial Orthoptera, preserved on a slab of Eocene Tertiary grey-coloured (*freshwater*) Limestone, associated with stems of rushes or other grass-like leaved aquatic plants. The under side of the left elytron is seen with many of its veins intact, and I have succeeded in reproducing the longitudinal framework (see Woodcut, Fig. 5). The right elytron is present only as an impression.

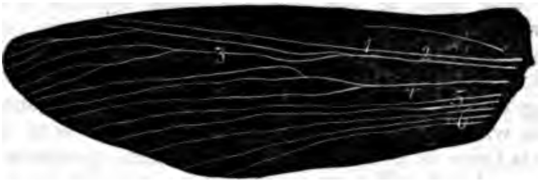


FIG. 5. Diagram of the longitudinal framework of the under side of the left elytron of *Gryllacris Ungeri*, Heer.

The surface of the mud tablet bearing the delineation of the *Gryllacris* reveals to us the aqueous nature of the vegetation of the locality where it once found its home and the nature of its food plants. It has been restored as crawling on a specimen from its associated herbarium, a kind of extinct pond-weed, or rather tassel-grass (*Ruppia*). Some scales and the vertebræ of a small fish lie on the stone just in advance of its head, in the original; and assist in elucidating and illustrating this page of its natural history.

Although probably never gazed on by human eyes, this grasshopper was not devoid of ornament. It had spotted elytra or wing-covers, and boldly blotched or perhaps coloured under wings; so that while thus it recalls to our mind the most handsome group of recent species of *Gryllacris*, it also connects them, as I shall endeavour to show, by an exposition of the venation of the elytra, with more ancient Orthopterous forms that peopled our earth in the dim and far-off Carboniferous ages.

Corydalis Brongniarti, Audouin. Under side of right elytron, see Plate XIV. Fig. 3.

This species, before noticed, from the Coal-measures of Coalbrookdale, Shropshire, is preserved to us in a wing, presumably the left elytron, of an Orthopterous insect, lying on the cleft nodule, with its under surface, on which it very probably rested during its interment, exposed.

This specimen, previously remarkable for the delicate venation it displays, acquires additional interest in a serrated vein that lies near its base: with little doubt the active agent of an organ of stridulation, similar to that possessed by the male house-cricket, and with which this insect effects its incessant "cree-cree."

To begin with the venation of the wing. If we compare the elytron of *G. Ungeri*, Fig. 5, with that of the modern *Gryllacris*, shown on our Plate at Fig. 1, it is at once seen, that although the venation has in each instance the same typical sub-parallel arrangement of its longitudinal branches, in *G. Ungeri* the limbs 1 and 2 of the scapular vein lie closer together, are *more parallel*, and the principal limb (2) forms *an elbow* or obtuse angle before its middle

This peculiarity, while it increases the transverse rigidity of the elytron, and seems to contract the marginal and internomediate fields, and approximates the externomediate vein (3) to the principal limb of the angular (2), with which it coincides a little before the elbow.

If we now turn to the Coalbrook-dale elytron, Plate XIV. [illegible] we see this characteristic well marked, but in conjunction with other elements, which deserve prominence from the indications they afford us of a slight aberration from the minor characters in a wing of the cricket or *Gryllacris* type, this is obviously in accordance with the increase of wing area, which here, it will be observed, is twice as great as that of any recent species with which we are acquainted. These modifications are briefly comprised in the greater branching of the large longitudinal veins, and occasional dividing of the transverse veinlets that brace them together, with the less parallel disposition of the former. It is to be regretted that the imperfect preservation of the Eocene insects forbids the institution of accurate comparisons on these points, which certainly indicate a greater expanse or decrease in toughness or elasticity in the wing membrane; and the more so as this wing seems to constitute a type to which the fragments of the *G. lithanthraca*, Heer, from the Saarbrück Coal-fields, may be referable.

File.—As a rule the file characterizes the male of the crickets and leaf-crickets, and although I cannot succeed in finding a species of *Gryllacris* with an effective file, it may nevertheless sometimes be found beneath the base of the elytron of these insects in a membranous form, as seen in Plate XIV. Fig. 1. Little more is to be gained from an examination of the remains of *G. Ungeri*, which only presents a circular vein of questionable import at the base of the under side of the right elytron, marked by a few doubtful indentations.

In the Coalbrook-dale elytron the file is well marked, and judging from the fact of its traversing the internomediate field of the elytron, its form, the character presented in its lower extremity, where the teeth are largest, it exhibits to us the nearest resemblance to the file or lima of the male house-cricket, as figured by Newport or Landois. (I have by me drawings of the file of the male European house and field-crickets, and hand specimens of those of the males of various leaf-crickets.) The house-cricket, as is well known, "sings" by partially opening and shutting its raised elytra, during which the file on the under side of the upper moves its teeth somewhat diagonally over a vein at the upper surface of the opposite elytron or wing-cover placed beneath, as Goureau has long ago informed us in his able and interesting paper contained in the Annales de la Soc. Entomol. de France. The mechanism of its file, as shown at Plate XIV. Fig. 4, is from a drawing by Newport, and the microscopic structure has recently been thus described by Landois:—

"Each wing-cover in the cricket has a shrill vein for vibration, analogous in form and position to that of the field-cricket. On its under surface are numerous bridges, about 200 in number, projecting and placed crossways on the vein. In the cricket the bridges are placed much closer than in the field-cricket, and their free and upper edges are somewhat longer. Their shape is a half-moon, and they are severally fastened to the shrill vein by a kind of columnar prop at their centre. They are not quite perpendicular, but placed slightly obliquely; and the friction takes place at their flat and concave upper edges when the wing-covers are rubbed or fiddled upon one another. These bridges are not of like dimensions, and at the origin and termination of the shrill vein are very small and poorly developed, and of little power in stridulation. In the central part of the vein they are well developed. They amount to something like 143, and have the following dimensions: Breadth, 0·0028 in.; height, 0·0005 in.; breadth of the prop, ·0011 in."

The microscopic character of the file shown by the fossilized elytron of *G. Brongniarti* may be thus generally given.

The lower part is broken away, so that the portion remaining in the anal field shows only ten large teeth, each ·015 in. broad, of triangular profile; these run obliquely across it, and present their vertices or edges to the fore-margin of the elytron. These teeth or bridges are then attenuated from the point where they enter the internomediate field; more than twenty are observed to traverse in a flattened curve, in a direction almost at a right angle to their former course, to the vicinity of the scapular vein, where they vanish: the whole adjustment presenting the curved line of a flat parabola or ellipse, with semi-major and minor axes of ·16 in. and ·1 in.

Thus, then, we see that this ancient instrument of music had already attained, to all appearance, an efficiency at least thrice that of our modern house-cricket, and must have emitted notes that rang widely over the tropical forest that clothed our island in the old days of the Coal period; and we may conjecture that each afternoon and evening it enlivened the stilly watery surfaces with its dull and incessant scraping.[1]

These plaintive love-notes, weird and wild, doubtless evoked a thrill of kindred emotion in the bosoms of numberless Batrachia, who found a home amid the swamps and morasses abounding in those ancient Cryptogamic Forests, and who answered, by a chorus of equal sweetness, the music of their Orthopterous companions.

EXPLANATION OF PLATE XIV.

FIG. 1.—*Gryllacris* (recent). Under surface of left elytron. Twice natural size.
1 and 2. The bifurcate scapular vein.
3. Externomediate vein.
4. Internomediate vein.
5 and 6. Anal vein.

FIG. 2.—*Gryllacris Ungeri*, Heer (restored). From the Eocene Tertiary, Radoboj, Austrian Croatia. Natural size. Plant, *Ruppia pannonica*, Unger.

FIG. 3.—*Gryllacris* (*Corydalis*) *Brongniarti*, Audouin, sp. Under surface of left elytron, showing what appears to be the file of an Orthopterous insect.

FIG. 4.—File of the organ of stridulation of the common house-cricket, from Newport's figure in Tod's Anatomy. Much magnified.

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[1] Indeed it must have done so did its possessor at all aspire to the habits of two great sections of our modern Saltatorial Orthoptera.

II.—The Source of Volcanic Heat.

By G. Poulett-Scrope, F.R.S., F.G.S., etc.

IN his letter to the Editor, inserted in the last Number of this Magazine (p. 332), Mr. Mallet says he is "compelled to repeat" the statements he had persistently made, and I had more than once denied, as to my having, "in almost all my writings," upheld "the moribund thin crust and liquid nucleus theory," and "Hopkins's fiery lakes."[1] He defends himself from the charge of having "misapprehended," as was suggested in an Editorial foot-note to his paper, or, as I more truly phrased it, "misrepresented," my views on these subjects, refusing to be bound by what I may have "written in the scattered magazine articles" to which he was referred, on the plea that "an author's notions are usually gathered from his acknowleged systematic works." Now when one public writer imputes to another opinions which the latter denies to have ever been his, candour and courtesy—not to speak of higher considerations—surely require of the former some examination into the fact before he repeats the imputation. What then is the fact? The only "systematic work" on volcanic geology to which I can plead authorship is the Treatise on Volcanos, etc., pp. 462, Longmans, 1862, re-issued without alteration, 1872, with which Mr. Mallet must be acquainted, since he did me the honour to accept a copy from me in, I think, the year 1865. Had Mr. Mallet, upon my disavowal of the views he imputed to me, before repeating the imputation twice over, only taken the trouble to open the volume and consult the Index, or but cursorily turn it over, he must have seen in its proper place in the work two pages, headed in capitals, "THEORY OF A FLUID NUCLEUS TO THE GLOBE, DOUBTFUL." In these two pages and the subsequent four (264–269), I give my reasons in detail for believing that *the globe is at present solid throughout,* with the exception of such locally "separate parts or pockets, as it were, of more or less intensely heated and liquefied mineral matter, as may exist at greater or less depths or distances," within or beneath the "foci" of active volcanos (p. 267). To this last extent, and no further, I expressed my concurrence with Mr. Hopkins's theory, while dissenting from his view of "a widely extended belt or continuous shell of molten mineral matter between the nucleus of the globe, *solidified by compression,* and its outer crust" (p. 268). In fact, I there, as well as in my "scattered writings," expressed opinions the very reverse of those so pertinaciously fastened upon me by Mr. Mallet. And were I to assert that he, "in his writings" upon earthquakes, had attributed them to the oscillations of an extremely thin crust over a liquid nucleus, I should not misrepresent his views more completely than he has misrepresented mine upon the source of volcanic energy. I venture, then, to put the question to the scientific world, whether any reputation can be secure, if it be allowable for a writer, publishing his work from the vantage-ground of the Royal Society's Philosophical Transactions, and with the object of maintaining a theory of his own, to impute to another writer on the subject opinions which he has not only not enunciated, but which he has in his "systematic works," as well as in others, disavowed in the emphatic and conspicuous manner employed by me in the passages above referred to concerning the views "saddled upon me" by Mr. Mallet? And I ask, further, when the imputation has been denied, is it consistent with the courtesy and honourable conduct usual among gentlemen that it should be repeated again and again, when it would have been so easy to refer to the work in which its incorrectness, to use no stronger word, lies patent to the most cursory glance?

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[1] In order that there may be no room for evasion as to the nature of the theory attributed to me from first to last by Mr. Mallet, I quote here one or two passages from his "Reply" to my Observations on his Theory, etc., Geol. Mag. for March, 1874, p. 127:—"The so-called mechanical theory of a liquid nucleus, that is, of a nucleus in liquid fusion beneath an extremely thin solid crust, has already given way, etc." "*Mr. Scrope's own notions, which involve that very thin crust and liquid nucleus, as most recently formulated by him,* do not, I believe, materially differ from those formed and enunciated by him some thirty years ago." . . . "The progress of science has, however, shown the untenability of *the views still espoused by Mr. Scrope,* of an immense liquid nucleus, and an excessively thin solid crust, as well as the notion of subterranean fiery lakes, or a continuous liquid shell between the crust and nucleus." . . . "Yet this gigantic incandescent nucleus and parenchymatous surface skin Mr. Scrope, and the school to which he belongs, must have, or their *ories are impossible.*"

But Mr. Mallet has a peculiar way of conducting a scientific controversy, as will be evident to all who have looked into his paper, where, to take one example, in the compass of half a dozen lines (p. 152), he expresses his contempt for Mr. Hopkins's "fiery lakes," as he styles them, in the following choice epithets: "a lame and gratuitous hypothesis," "feeble and unconvincing," "most improbable," "erroneous and untenable," "inherently improbable,"—epithets which, as in other instances that might be adduced,[1] Mr. Mallet seems to consider a sufficient and complete refutation of the opinions he has thus denounced. True it is that Mr. Hopkins's views are wholly at variance with Mr. Mallet's rock-crushing derivation of volcanic heat, and therefore to be "put down." But it is not unimportant to observe that the former has the support of Professors Dana and Sterry Hunt, dynamical geologists of far higher authority than Mr. Mallet.[2]

One word upon a passage in Mr. Mallet's last letter in the GEOL. MAG. for July, p. 332, which professes to be an argument against my view of the derivation of volcanic heat from "a rise in geothermal temperature produced by deposition of sediment," namely, that "no body can raise the temperature of another by conductive transference of part of its heat to a temperature as high as its own, and therefore, if the subcortical matter of our globe" (as I have supposed) "passes locally under varying conditions of heat and pressure . . . to a liquid or even vaporous state, there must be matter more deeply situated at a still higher temperature, i.e. *there must be a liquid nucleus.*" Was there ever such a *non sequitur* as is contained in this last phrase? It lays down as a law in physics that "no body" can by conduction reduce another body to fusion, unless it be itself fused—a proposition which every plumber's apprentice and every boy who melts ice with a hot poker practically refute. But if we charitably give Mr. Mallet credit for not intending to broach this palpable absurdity (although his words imply it), but suppose him to have in view not *all* bodies, but only subterranean rocky matter, can he deny that some rocky strata may, owing to their peculiar composition or structure, or permeation with water, or other conceivable conditions, enter into fusion or igneo-aqueous plasticity at a somewhat lower temperature than that at which some other subjacent or adjacent rock retains its solidity? Or again, will Mr. Mallet deny that pressure may raise the fusing point of rocky matter composing a deeply buried stratum or zone, so as to maintain it in a solid state at a higher temperature than that at which a body of the same material above it, but exposed to a less amount of pressure, will enter into fusion? The whole passage I believe to be as false in physics as it is dogmatic in tone. And yet Mr. Mallet looks down with supreme contempt, from what he calls "the lofty point of Thermo-dynamics" (p. 147, op. cit.), upon "the erroneous notions on these subjects commonly current among geologists"!

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[1] See for another example p. 133 of Reply, etc. (GEOL. MAG. for March, 1874), in which Mr. Mallet, after declaring that "the limits within which the fusing temperature of rocks can be raised or lowered by difference of pressure are *unquestionably* too small to play any important part in geologic phenomena," adds: "The notion was seized upon by Hopkins as offering some *feeble* support to his *wild hypothesis* of subterranean lava-lakes." And lower, in the same page, he characterizes my "notion" that water existed in the rock-matter from which lava is formed previously to its fusion, as "wholly untenable," and again, three lines further on, as "utterly untenable"—a favourite epithet with Mr. Mallet, and employed by him, here as elsewhere, in lieu of argument.

[2] See Silliman's Journal for July, 1873, p. 10, and the same work for April, 1873, pp. 264-7.

Mr. Mallet dismisses me with a challenge to reduce my views as to the origin of volcanic heat to "a definition," such as that which figures conspicuously in p. 167 of his paper. It is of course easy to give an imposing air to an opinion or conjecture by printing it in italics, with the title of "Definition" above it. And it is perhaps natural, after doing so, to fancy that you have thereby demonstrated its truth—as Mr. Mallet repeatedly affirms that he has done. But it remains after all a mere guess—more or less plausible according to the arguments, observations, or experiments by which it can be supported. I have already said that I am not prepared to dogmatize on this obscure and difficult question; but in my recent letter in the GEOL. MAG. for May, 1874, p. 237, I briefly stated what I will here repeat, my preference over Mr. Mallet's theory as to the exclusive origin of volcanic heat in the crushing of superficial rocks as they follow downwards a shrinking nucleus, of the opinion that it (volcanic heat) is derived chiefly and directly by conduction or convection, or both, from that intensely heated interior mass of the globe upon which Mr. Mallet's own theory rests as a postulate.

Let me briefly dissect Mr. Mallet's "Definition."

That the globe is a condensed nebula still gradually cooling from a state of fusion, is an hypothesis only; though, I admit, a plausible one. [illegible] *its nucleus* is consequently shrinking, is another hypothesis, which the recent dispute among physicists, to which Mr. Mallet has been a party, whether mineral matter when consolidating (and especially when crystallizing), from a state of fusion, expands or contracts, shows to be yet doubtful. That such shrinking, if it really occurs, takes effect, not in the production of internal rents, but in "the more or less free descent of the shell by gravitation," is again but a conjecture. And that "the compression or crushing of portions of that shell" thereby occasioned produces an amount of heat, "locally within the solid shell," sufficient to effect its partial fusion, is a further conjecture which, from the probable slowness of the crushing process, if it does take place at all, and the many other modes in which the energy so set in motion may be supposed to be dissipated without the development of any extraordinary amount of heat (as I suggested in the GEOLOGICAL MAGAZINE for May, 1874, p. 237), can hardly be considered, I think, more than possible. Lastly, if all these hypotheses be granted, what proof or probability is there that the heat so generated by an action which must be supposed general and uniform throughout the entire subsiding shell,[1] does not merge in the general body of heat transmitted through it by conduction from the heated interior of the globe, but is exclusively directed towards the volcanic vents or fissures, "few and far between," which penetrate its surface? The extremely small fractional proportion of the total amount of heat that escapes into outer space through volcanic activity, which Mr. Mallet himself estimates at only 1 in 1500,[2]—instead of being, as Mr. Mallet seems to suppose it, an argument in favour of his theory, tells, in fact, strongly against it, since it is reasonable to presume that the smaller fractional portion of heat observed to escape from the surface of the globe proceeds chiefly, if not wholly, from the same source as the larger, namely, that enormous store of heat which the interior of the globe on Mr. Mallet's own view contains, and of which such a vast amount is continually transmitted by conduction to its surface. It is strange that Mr. Mallet should not have perceived the true inference from his figures. He argues, in fact, that because the amount of heat lost from the globe through volcanic vents is infinitesimally small as compared with that lost by superficial radiation into space, *therefore* the former *must* proceed from a different source from that which produces the latter. It might just as well be argued that because the heat received by our globe from the sun is but a minute fraction of the total amount of solar heat radiated through space, therefore the former must have a different origin in the composition of the sun from the latter. If any further argument were needed to show the fallacy of Mr. Mallet's exclusive reference of volcanic heat to the crushing of subsiding rocky matter, it might be found in the fact that the traces of extreme crushing, such as corrugation, slaty cleavage, etc., do not occur in volcanic regions—which rarely show signs of much disturbance, but only dykes, *i.e.* narrow fissures filled with lava-rock, cutting through undisturbed, or but slightly disturbed strata, making it probable (as I said in my first notice of Mr. Mallet's theory) that if any heat is, or ever was, generated by the compression of rocks, its effects should be looked for rather in the metamorphosed and plicated rocks of mountain chains than in the lines of volcanic eruption.

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[1] In Mr. Mallet's own words, "not a mere local phenomenon, but a great cosmical condition, pervading every part of the thick and solid crust of the globe," p. 130 of Reply, GEOL. MAG. for March, 1874.

[2] "I have proved that the total amount of heat annually carried off from our globe by existing volcanic action cannot by any possibility exceed the $\frac{1}{1500}$ part of the total heat annually *dissipated from our globe.*"—Mallet, *loc. cit.* p. 131.

I must apologise to the readers of the GEOLOGICAL MAGAZINE for this continued controversy with Mr. Mallet, on the double ground of, 1st, that gentleman's repeated and persevering misrepresentation of my views on volcanic action, and 2ndly, the inherent weakness of the theory he has advanced with so much pretension as "a precise and true theory, in substitution for the current and erroneous notions as to the nature of those forces, from the play of which, within our globe, those grand phenomena of nature (volcanos) are produced." —Phil. Trans. p. 147.

III.—ON THE PHYSICAL CAUSE OF THE SUBMERGENCE AND EMERGENCE OF THE LAND DURING THE GLACIAL EPOCH.

By JAMES CROLL, of the Geological Survey of Scotland.

(*Continued from page* 314.)

THE greatest extent of the displacement of the earth's centre of gravity, and consequently the greatest rise of the ocean resulting from that displacement, would of course occur at the time of maximum glaciation, when the ice would be all on one hemisphere. But owing to the following circumstance, a still greater rise than that resulting from the displacement of the earth's centre of gravity alone might take place at some considerable time, either before or after the period of maximum glaciation.

It is not at all probable that the ice would melt on the warm hemisphere at exactly the same rate as it would form on the cold hemisphere. It is probable that the ice would melt more rapidly on the warm hemisphere than it would form on the cold. Suppose that during the Glacial epoch, at a time when the cold was gradually increasing on the northern and the warmth on the southern hemisphere, the ice should melt more rapidly off the Antarctic Continent than it was being formed on the Arctic and Sub-arctic regions; suppose also that, by the time a quantity of ice, equal to one-half what exists at present on the Antarctic Continent, had accumulated on the northern hemisphere, the whole of the Antarctic ice had been melted away, the sea would then be fuller than at present by the amount of water resulting from the one mile of melted ice. The height to which this would raise the general level of the sea would be as follows:—

The Antarctic ice-cap is equal in area to $\frac{1}{23{\cdot}46}$ of that covered by the ocean. The density of ice to that of water being taken at ·92 to 1, it follows that 25 feet 6 inches of ice melted off the cap would raise the general level of the ocean one foot, and the one mile of ice melted off would raise the level 200 feet. This 200 feet of rise resulting from the melted ice we must add to the rise resulting from the displacement of the earth's centre of gravity. The removal of the two miles of ice from the Antarctic Continent would displace the centre of gravity 190 feet, and the formation of a mass of ice equal to the one-half of this on the Arctic regions would carry the centre of gravity 95 feet further; giving in all a total displacement of 285 feet, thus producing a rise of sea-level at the North Pole of 285 feet, and in the latitude of Edinburgh of 234 feet. Add to this the rise of 200 feet resulting from the melted ice, and we have then 485 feet of submergence at the Pole, and 434 feet in the latitude of Edinburgh. A rise to a similar extent might probably take place after the period of maximum glaciation, when the ice would be melting on the northern hemisphere more rapidly than it would be forming on the southern.

If we assume the Antarctic ice-cap to be as thick as is represented in the diagram, the extent of the submergence would of course be double the above, and we might have in this case a rise of sea-level in the latitude of Edinburgh to the extent of from 800 to 1000 feet. But be this as it may, it is evident that the quantity of ice on the Antarctic Continent is perfectly sufficient to account for the submergence of the Glacial epoch, for we have little evidence to conclude that the *general* submergence much exceeded 400 or 500 feet.[1] We have evidence in England and other places of submergence to the extent of from 1000 to 2000 feet, but these may be quite local, resulting from subsidence of the land in those particular areas. Elevations and depressions of the land have taken place in all ages, and no doubt during the Glacial epoch also.

In favour of this view of the cause of the submergence of the Glacial epoch, it is a circumstance of some significance, that in every part of the globe where glaciation has been found, along with it, evidence of the submergence of the land has also been found. The invariable occurrence of submergence along with glaciation points to some physical connexion between the two. It would seem to imply, either that the two were the direct effects of a common cause, or that the one was the cause of the other; that is, the submergence the cause of the glaciation, or the glaciation the cause of the submergence. There is, I presume, no known cause to which the two can be directly related as effects. Nor do I think that there is any one who would suppose that the submergence of the land could have been the cause of its glaciation, even although he attributed all Glacial effects to floating ice. The submergence of our country would, of course, have allowed floating ice to pass over it had there been any to pass over; but submergence would not have produced the ice, neither would it have brought the ice from the Arctic regions where it already existed. But although submergence could not have been the cause of the Glacial epoch, yet we can, as we have just seen, easily understand how the ice of the Glacial epoch could have been the cause of the submergence. If the Glacial epoch was brought about by an increase in the eccentricity of the earth's orbit, then a submergence of the land as the ice accumulated was a physical necessity.

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[1] In a former paper I considered the effects of another cause, viz. the melting of polar ice resulting from an increase of the Obliquity of the Earth's Orbit.—Trans. Glasgow *Geol. Soc. vol. ii. p. 177.* Phil. Mag. June, 1867 (Supplement).

There is another circumstance connected with Glacial submergence which it is difficult to reconcile with the idea that it resulted from a subsidence of the land. It is well known that during the Glacial epoch the land was not once under water only, but several times; and, besides, there were not merely several periods when the land stood at a lower level in relation to the sea than at present, but there were also several periods when it stood at a much higher level than now. And this holds true, not merely of our own country, but of every country on the northern hemisphere where glaciation has yet been found. All this follows as a necessary consequence from the theory that the oscillations of sea-level resulted from the transference of the ice from the one hemisphere to the other; but it is wholly inconsistent with the idea that they resulted from upheavals and subsidence of the land during a very recent period.

But this is not all, there is more still to be accounted for. It has been the prevailing opinion that at the time when the land was covered with ice, it stood at a much greater elevation than at present. It is, however, not maintained that the facts of geology establish such a conclusion. The greater elevation of the land is simply assumed as an hypothesis to account for the cold (Phil. Mag. for Nov. 1868, p. 376). The facts of geology, however, are fast establishing the opposite conclusion, viz. that when the country was covered with ice, the land stood in relation to the sea at a lower level than at present, and that the continental periods or times when the land stood in relation to the sea at a higher level than now were the warm interglacial periods, when the country was free of snow and ice, and a mild and equable condition of climate prevailed. This is the conclusion towards which we are being led by the more recent revelations of surface geology, and also by certain facts connected with the geographical distribution of plants and animals during the Glacial epoch.

The simple occurrence of a rise and fall of the land in relation to the sea-level in one or in two countries during the Glacial epoch, would not necessarily imply any physical connexion. The coincidence of these movements with the glaciation of the land might have been purely accidental; but when we find that a succession of such movements occurred, not merely in one or in two countries, but in every glaciated country where proper observations have been made, we are forced to the conclusion that the connexion between the two is not accidental, but the result of some fixed cause.

If we admit that an increase in the eccentricity of the earth's orbit was the cause of the Glacial epoch, then we must admit that all those results followed as necessary consequences. For if the Glacial epoch lasted for upwards of one hundred thousand years or so, there would be a succession of cold and warm periods, and consequently a succession of elevations and depressions of sea-level. And the elevations of the sea-level would take place during the cold periods, and the depressions during the warm periods.

But the agreement between theory and observed facts does not terminate here. It follows from theory that the greatest oscillations of sea-level would take place during the severest part of the Glacial epoch, when the eccentricity of the earth's orbit would be at its highest value, and that the oscillations would gradually diminish in extent as the eccentricity diminished and the climate gradually became less severe. Now it is well known that this is actually what took place; the great submergence, as well as the great elevation or continental period, occurred during the earlier or more severe part of the Glacial epoch, and as the climate grew less severe these changes became of less extent, till we find them terminating in our submerged forests and 25-foot raised beach.

It follows therefore, according to the theory advanced, that the mere fact of an area having been under sea does not imply that there has been any subsidence or elevation of the land, and that consequently the inference which has been drawn from these submerged areas as to changes in physical geography may be in many cases not well founded.

Sir Charles Lyell, in his "Principles," publishes a map showing the extent of surface in Europe which has been covered by the sea since the earlier part of the Tertiary period. This map is intended to show the extraordinary amount of subsidence and elevation of the land which has taken place during that period. It is necessary for Sir Charles's theory of the cause of the Glacial epoch that changes in the physical geography of the globe to an enormous extent should have taken place during a very recent period, in order to account for the great change of climate which occurred at that epoch. But if the foregoing results be anything like correct, it does not necessarily follow that there must have been great changes in the physical geography of Europe, simply because the sea covered those areas marked in the map, for this may have been produced by oscillations of sea-level, and not by changes in the land. In fact, the areas marked in Sir Charles's map as having been covered by the sea, are just those which would be covered were the sea-level raised a few hundred feet. No doubt there were elevations and subsidences in many of the areas marked in the map during the Tertiary period, and to this cause a considerable amount of the submergence might be due; but I have little doubt that by far the greater part must be attributed to oscillations of sea-level. It is no objection that the greater part of the shells and other organic remains found in the marine deposits of those areas are not indicative of a cold or glacial condition of climate, for, as we have seen, the greatest submergence would probably have taken place either before the more severe cold had set in or after it had to a great extent passed away. That the submergence of those areas probably resulted from elevations of sea-level rather than depressions of the land, is further evident from the following considerations. If we suppose that the climate of the Glacial epoch was brought about mainly by changes in the physical geography of the globe, we must assume that these great changes took place, geologically speaking, at a very recent date. Then when we ask what ground is there for assuming that any such change in the relations of sea and land as is required actually took place, the submergence of those areas is adduced as the proof. Did it follow as a physical necessity that all submergence must be the result of subsidence of the land, and not of elevations of the sea, there would be some force in the reasons adduced. But such a conclusion by no means follows, and, *à priori*, it is just as likely that the appearance of the ice was the cause of the submergence as that the submergence was the cause of the appearance of the ice. Again, a subsidence of the land to the extent required would to a great extent have altered the configuration of the country, and the main river-systems of Europe; but there is no evidence that any such change has taken place. All the main valleys are well known to have existed prior to the Glacial epoch, and our rivers to have occupied the same channels then as they do now. In the case of some of the smaller streams, it is true, a slight deviation has resulted at some points from the filling up of their channels with drift during the Glacial epoch; but as a general rule all the principal valleys and river-systems are older than the Glacial epoch. This, of course, could not be the case if a subsidence of the land sufficiently great to account for the submergence of the areas in question, or changes in the physical geography of Europe necessary to produce a Glacial epoch, had actually taken place. The total absence of any geological evidence for the existence of any change which could explain either the submergence of the areas in question or the climate of the Glacial epoch, is strong evidence that the submergence of the Glacial epoch, as well as of the areas in question, was the result of a simple oscillation of sea-level resulting from the displacement of the earth's centre of gravity by the transference of the ice-cap from the southern to the northern hemisphere.

Oscillations of sea-level in relation to Distribution.—The oscillations of sea-level resulting from the displacement of the earth's centre of gravity help to throw new light on some obscure points connected with the subject of the geographical distribution of plants and animals. At the time when the ice would be on the southern hemisphere during the Glacial epoch, and the northern hemisphere enjoying a warm and equable climate, the sea-level would be several hundred feet lower than at present, the North Sea would probably be dry land, and Great Britain and Ireland joined to the continent, thus opening up a pathway from the continent to our island. As has been shown in former papers (*Phil. Mag.* November, 1868; August, 1864; June, 1867, *Supplement*), during the inter-glacial periods the climate would be much warmer nd more equable than now, so that animals from the south, such as the ppopotamus, hyæna, lion, *Elephas antiquus* and *Rhinoceros mega-* *us*, would migrate into this country, where at present they could not live in consequence of the cold. We have therefore an explanation, as was suggested on a former occasion (*Phil. Mag.* Nov. 1868), of the fact that the bones of these animals are found mingled in the same grave with those of the musk ox, mammoth, reindeer, and other animals which lived in this country during the cold periods of the Glacial epoch; the animals from the north would cross over into this country upon the frozen sea during the cold periods, while those from the south would find the English Channel dry land during the warm periods.

The same reasoning will hold equally true in reference to the old and new world. The depth of Behring Straits is under thirty fathoms; consequently a lowering of the sea-level of less than 200 feet would connect Asia with America, and thus allow plants and animals, as Mr. Darwin believes, to pass from the one continent to the other.[1] During this period, when Behring Straits would be dry land, Greenland would be comparatively free from ice, and the Arctic regions enjoying a comparatively mild climate. In this case plants and animals belonging to temperate regions could avail themselves of this passage, and thus we can explain how plants belonging to temperate regions may have, during the Miocene period, passed from the old to the new continent, and *vice versâ*.

As has already been noticed, during the time of the greatest extension of the ice, the quantity of ice on the southern hemisphere might be considerably greater than what exists on the entire globe at present. In that case there might, in addition to the lowering of the sea-level resulting from the displacement of the earth's centre of gravity, be a considerable lowering resulting from the draining of the ocean to form the additional ice. This decrease and increase in the total quantity of ice which we have considered would affect the level of the ocean as much at the equator as at the poles; consequently during the Glacial epoch there might have been at the equator elevations and depressions of sea-level to the extent of a few hundred feet.

Extent of submergence on the hypothesis that the earth is fluid in the interior.—But we have been proceeding upon the supposition that the earth is solid to its centre. If we assume, however, what is the general opinion among geologists, that it consists of a fluid interior surrounded by a thick and rigid crust or shell, then the extent of the submergence resulting from the displacement of the centre of gravity for a given thickness of ice must be much greater than I have estimated it to be. This is evident, because, if the interior of the globe be in a fluid state, it, in all probability, consists of materials differing in density. The densest materials will be at the centre, and the least dense at the outside or surface. Now the transference of an ice-cap from the one pole to the other will not merely displace the ocean—the fluid mass on the outside of the shell—but it will also displace the heavier fluid materials in the interior of the shell. In other words, the heavier materials will be attracted by the ice-cap more forcibly than the lighter, consequently

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[1] *Origin of Species*, chap. xi. (fifth edition).

they will approach towards the cap to a certain extent, sinking, as it were, into the lighter materials, and displacing them towards the opposite pole. This displacement will of course tend to shift the earth's centre of gravity in the direction of the ice-cap, because the heavier materials are shifted in this direction, and the lighter materials in the opposite direction. This process will perhaps be better understood from the following figures.

Fig. 2.

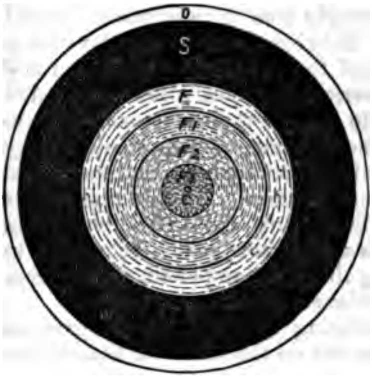
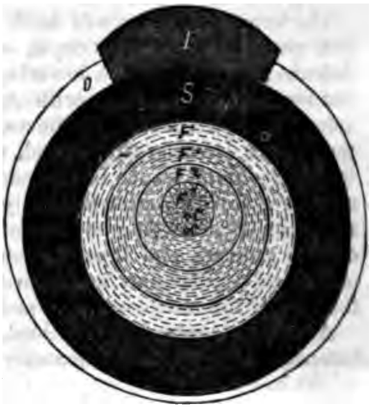


Fig. 3.



O. The Ocean. S. Solid Crust or Shell.
F, F^1, F^2, F^3. The various concentric layers of the fluid interior. The layers increase in density towards the centre.
I. The Ice-cap. C. Centre of gravity.
C^1. The displaced centre of gravity.

In Figure 2, where there is no ice-cap, the centre of gravity of the earth coincides with the centre of the concentric layers of the fluid interior. In Figure 3, where there is an ice-cap placed on one pole, the concentric layer F^1 being denser than layer F, is attracted towards the cap more forcibly than F, and consequently sinks to a certain depth in F. Again, F^2 being denser than F^1, it also sinks to a certain extent in F^1. And again, F^3, the mass at the centre, being denser than F^2, it also sinks in F^2. All this being combined with the effects of the ice-cap, and the displaced ocean outside the shell, the centre of gravity of the entire globe will no longer be at C, but at C^1, a considerable distance nearer to the side of the shell on which the cap rests than C, and also a considerable distance nearer than it would have been had the interior of the globe been solid. There are here three causes tending to shift the centre of gravity, (1) the ice-cap, (2) the displaced ocean, and (3) the displaced materials in the interior. Two of the three causes mutually re-act on each other in such a way as to increase each other's effect. Thus the more the ocean is drawn in the direction of the ice-cap, the more effect it has in drawing the heavier materials in the interior in the same direction, and in turn the more the heavier materials, in the interior, are drawn towards the cap, the greater is the displacement of the earth's centre of gravity, and of course, as a consequence, the greater is the displacement of the ocean. It may be observed also that, other things being equal, the thinner the solid crust or shell is, and the greater the difference in the density of the fluid materials in the interior, the greater will be the extent of the displacement of the ocean, because the greater will be the displacement of the centre of gravity.

It follows that if we knew (1) the extent of the general submergence of the Glacial epoch, and (2) the present amount of ice on the southern hemisphere, we could determine whether or not the earth is fluid in the interior.

IV.—GEOLOGICAL NOTES FROM THE NEIGHBOURHOOD OF CAIRO.

By JOHN MILNE, F.G.S.

THIS neighbourhood has already been described by several authors,—the most complete account of the Tertiary beds being by Dr. Fraas, Aus dem Orient, 1867. Dr. Figari Bey, in vol. i. of Studi Scientifici sull' Egitto; H. Bauerman, Esq., and Dr. C. Le Neve Foster, in the Quart. Journ. Geol. Soc. 1869, vol. xxv. p. 40, have also written on the district, the latter observers referring especially to the occurrence of Celestine in the Moccattam quarries.

The surroundings, of Cairo, being by no means a geological *terra incognita*, there will perhaps be but little to be gleaned in the way of additional particulars respecting this district from the following brief communication; it is therefore hoped it will be accepted rather as a note to accompany the few specimens collected[1] than as an independent paper.

Middens or Rubbish Heaps.—Outside Cairo, and noticeably so between its N.E. and S.W. sides, there are a number of dark-coloured low hills, forming a range about four or five miles in length, with an undulating surface,—in contour not unlike the Downs of our southern counties. In places these approach so closely to the city as partially to bury the walls with which it is surrounded, above which they rise rather steeply, at an angle of 25° to 28°, to a height of from 100 to 125 feet. On the opposite side, that is, towards the S.E., they slope more gradually, descending by a series of undulations and small valleys of the same depth as the hills are in height. The summit of these hills, which may be averaged at a quarter of a mile in width, and which, with the lateral ridges, is sufficient for the accommodation of numerous windmills, affords an extensive view towards the S.W. across Cairo to the Pyramids of Gizeh, and towards the E. over the plain in which are situated the Tombs of the Caliphs to the range of Moccattam. This view is represented as a diagram, in order to show the relation of the Red Hills to the Limestones of Moccattam, and also the dip of the strata. (See Woodcut, Fig. 1.)

It is not until these hills are approached and closely examined that their nature can be determined, after which one contemplates them with astonishment, and marvels that such an immense amou material, sufficient to build many such towns as the one from w it was derived, should have all been accumulated by human age

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[1] The specimens referred to, have been presented by the author to the British Museum.

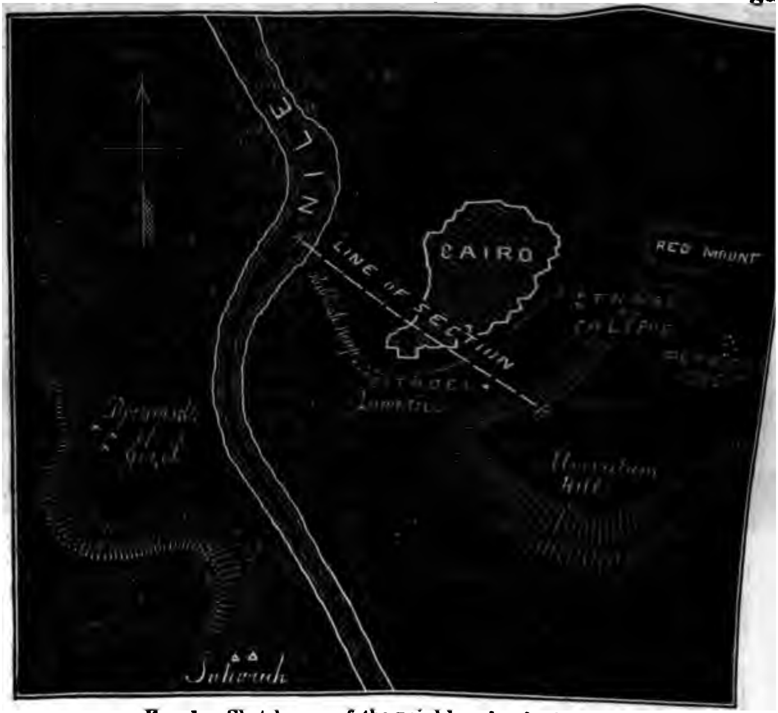

FIG. 1.—Sketch-map of the neighbourhood of Cairo.

Similar heaps to these are to be seen marking the position of many other cities, as at Memphis, where they may perhaps even exceed those at Cairo. No careful investigation of these vast Refuse Mounds appears at present to have been made. This Egyptian darkness may, perhaps, in part be removed by an archæological exploration of their contents, pottery and coins being interpreted by the antiquary as fossils are by the palæontologist.

On approaching these heaps from the end of the principal street in Cairo, "the Mosque," a definite dip at an angle of 4° or 5°, is seen towards the S.W. along a line about fifty yards in length.

Behind some limekilns at this point, about twenty-five feet above the base of the heap, there is a cutting in the side of the slope, about thirty feet in length and ten feet in height. The materials in this exposure are arranged in distinct layers, the chief constituents being comminuted fragments of brick and mortar, black soil, broken crockery, charred wood, fragments of bones, and a few land-shells, (*Helix*),—the pieces of wood and bones marking what may be termed *the stratification*, in which they are aided by a corresponding horizontality in all the pieces of crockery ware, which either fell in the position they now occupy, or else have gradually acquired it.

Many pieces of the pottery are highly coloured, rich greens and blues being common. On some of them designs, such as patterns of flowers, are noticeable. Small pieces of granite and quartz are also met with, and near the surface heads of old pipes and date-stones.

Bits of Nummulitic Limestone and detached Nummulites have travelled from the adjacent hills, to be imbedded with the rest; and on the eastern side of these heaps, near the summit, at about two or three feet from the surface, and occasionally on the surface itself, there are many recent shells.

The material covering the sides and tops of these ranges of hills only differs in being coarser than the rest, most of the finer débris having been washed down into the valley during rainy seasons, where it has accumulated and forms a fine mud-grit.

Plain of the Tombs of the Caliphs.—Lying between these rubbish heaps and the range of Moccattam Hills there is a narrow sandy plain, about a mile and a half in width. At the N.E. end of this, opposite Jebel Achmar or the Red Mountain, numerous small excavations have been made beneath the surface (which has a crispness, from the salt it contains), in order to obtain a fine greenish-grey gritty sand used for domestic purposes. In these openings numerous skulls and other human bones are seen strewn over the ground.

Not far from these small openings a trench, from fourteen to sixteen feet deep, had been excavated, about 300 yards in length, in the direction of the waterworks, giving a good superficial section of the desert, but not sufficiently deep to reach the limestone seen in the adjacent heights. For six feet from the surface there is a coarse sand, with occasional fragments of pottery, and innumerable human bones—skulls, femora, tibiæ, ribs, and in fact many almost perfect skeletons. Judging from the number of these remains, the way in which they are confusedly heaped together, and the wide extent of ground over which they extend, they probably resulted from some great epidemic, such as the plague, which may have visited the city long ago.

Looking at the depth at which these remains occur, and remembering that in Eastern countries it is customary to bury barely beneath the surface (?), it may be inferred, from the accumulation of sand and other materials above these relics of humanity, that a considerable time has elapsed since their interment.

Below six feet no more pottery exists, and excepting the fragment of a shell, only sand, containing innumerable flints and pieces of silicified wood, is to be seen.

Moccattam Quarries.—These truly historical quarries form a long line of cliffs, overlooking the eastern and south-eastern side of Cairo, the height of which above the Nile is about 800 feet, and above Cairo 525 feet, as will be seen in the accompanying sketch section, the elevations on which were approximately obtained by several aneroid observations. (See Woodcut, Fig. 2.)

The general *dip of the beds* forming this escarpment is towards the N.E., at an angle of from 4° to 5°, diminishing in height towards the north, in which direction they pass beneath the red quartzose hills of Jebel Achmar.

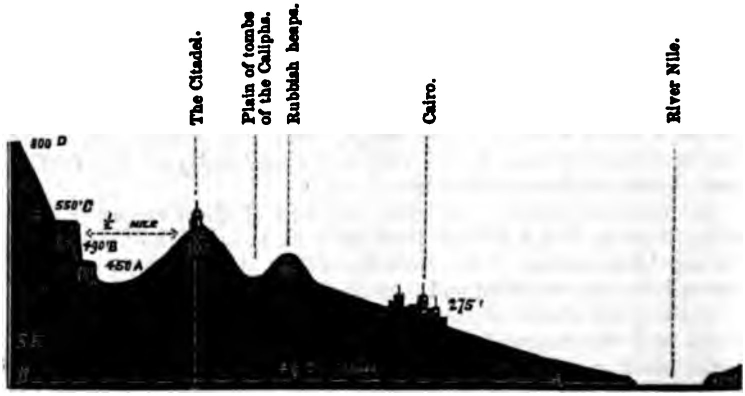

Fig. 2.—An approximate section along the line A-B on Fig. 1.

The section of these quarries is the largest and most noticeable excavation along the entire range, being worthy of a visit, if only to see the magnitude of the works which for past ages have been and still continue to be carried on. The quarries are situated behind the Citadel, a general plan of which is seen in Fig. 3, and in section Fig. 2, and Sketch-map Fig. 1.

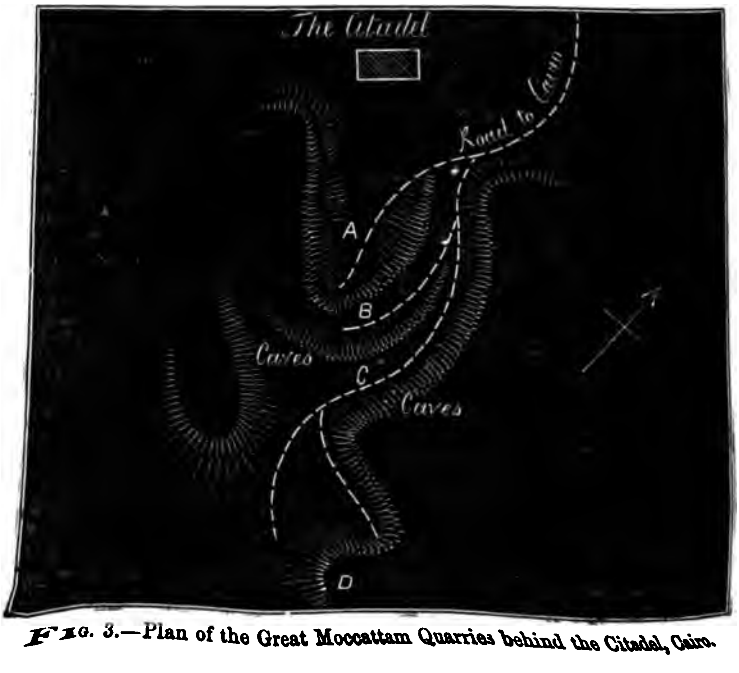

Fig. 3.—Plan of the Great Moccattam Quarries behind the Citadel, Cairo.

Reckoning from the walls of the Citadel, near which the excavations originally commenced, the hill has been cut back for a distance of about half a mile. The workings of the quarry are carried on along the face of three scarps, which, in conjunction with its semicircular form, give to it the appearance of an amphitheatre. Entering the quarries from the rear of the Citadel, the road divides; the lower branch leading into what might form the arena of a theatre (Fig. 3, A.), the lowest part of the quarry, 350 feet below the summit of the hill; the upper branch, after running a short distance towards the rear of the quarries, in its turn also splitting into two branches; one of which (Fig. 3, B.) leads along the base of the second scarp, forty feet above the lowest part of the quarry; whilst the other (Fig. 3, C.), after winding round the end of the quarry at from 80 to 90 feet above its lowest point, turns to the left, and passing through a narrow valley opposite to the Citadel, gradually ascends to the summit of the hill.

These different roads and levels are referred to in Section Fig. 2, and Plan Fig. 3, by corresponding letters.

A striking feature in this quarry is the immense blocks of stone which are scattered about in all directions. One of them, in the upper road C, in measurement was found to be 57 feet long, 18 feet high, and 18 feet thick, representing about 1400 tons of stone; and from one point on the road I counted upwards of forty blocks approximating to, and in many cases perhaps exceeding, the dimensions of the one just quoted. These blocks, which have been obtained by the undermining of the cliff, aided by natural vertical joints, now form small quarries in themselves, being more readily worked and broken in upon than the upright face of the cliff from which they were detached. Where these cliffs have been worked in upon, several large caves have been produced, the positions of which are indicated in Plan, Fig. 3. One of these shows a flat roof, about 30 or 40 feet in height, and 90 feet in an unsupported span.

Standing at a distance, and looking at the range of hills in which these quarries occur, it will be seen that there is a marked difference in colour between the rock forming the cap or head of the mountains and that exposed in the cutting below—the upper strata being reddish, whilst the lower ones are white, which at once suggests the idea, which has been followed out by previous observers, of dividing the beds, according to their physical aspects, into Brown Beds and White Beds. The thickness of the former beds behind the Citadel, as estimated by aneroid, is about 125 feet; whilst the exposure of the White Beds, from the junction with the Brown Beds above to the foot of the quarry, is about 225 feet.

These measurements may be compared with those of a section of the same beds taken about a mile and a half to the north, given in the paper by Messrs. Bauerman and Foster previously mentioned, from which it will be seen that behind the Citadel the Brown Beds have in so short a distance more than doubled their thickness.

Looking at these Brown Beds generally, it will be seen that their surface is much *weathered* and decomposed, and forms a reddish soil, which in places is clayey, this latter appearance being probably due to the decomposition of certain bands rather than to a breaking up of the whole. The White Beds are the well-known Nummulitic Limestone. This is soft, easily worked, and, when freshly broken, is perfectly white; but on exposure, it becomes slightly yellowish. Standing a short distance away from the face of this rock, a division in the beds is to be seen, marked by yellowish horizontal lines, which are in certain cases somewhat siliceous. In addition to these markings, there are others, more strongly defined, indicating fissures and cracks, which are often filled with a yellow oxide of iron, in certain cases of a sufficiently good quality to be used for a pigment.

Commencing at the summit of the hills behind the Citadel, the general succession of beds in their descending order is represented as follows. The letters refer to the fossils.

I.—*Red Beds.*

A. 1.—The capping beds here consist of a coarse limestone, almost wholly made up of shells. It is much weathered, and its surface is strewn with dark-coloured stones, the angles of which are much rounded. Externally these are very vesicular, like a hard burnt cindery slag; but on being broken, they are seen to be more compact, showing transverse sections of shells. These probably formed portions of still higher beds, which have been by a subaerial degradation carried away; their vesicular character being due to the dissolving out of a portion of the shelly matter of which they are almost wholly made up.

These top beds are traversed in various directions by a few small veins of gypsum, which are generally not more than a quarter of an inch in thickness.

B. 2.—About 30 feet below these beds of limestone we get a reddish yellow band of soft calcareous sandstone. In places this is siliceous, and from its friability almost becomes a sand, whilst in its lower portions it resembles a loam. It contains but few fossils, but in one portion it is full of numerous small nests of crystallized carbonate of lime. These crystals are small, but all more or less assume the same geometrical form,—that of a scalenohedron, terminated by the planes of an obtuse rhombohedron.

3.—At the base of this there is a band apparently wholly made up of Oyster-shells.

C. 4.—Below this there are six feet of a yellowish earthy band, which is followed by a three-foot band of Oysters.

D. 5.—Still lower we come on more yellow sandstone and a thin band of shells, the base of which is about 60 feet from the summit of the hill.

E. 6.—Below this 60-foot level the sides of the hill are covered with a soft earthy mass of sand, produced by the disintegration of the rocks above, which to a great extent conceals the underlying *strata*. A slight efflorescence of salt, giving a whitish appearance to the ground, together with a few veins of fibrous gypsum coursing upwards, is all that is observable.

A few yards to the N.E. side of the road a cutting about 20 feet in depth has been made, exposing compact beds of yellowish sand. Running through the face of this there are five almost horizontal bands of gypsum, under one of which, and almost in contact with it, is a narrow band of Oysters, which, being more compact than the beds of sand, stand out to form a small ledge. The largest of these bands is not more than three inches in thickness. Between them, imbedded in the sand, several hollow and angular shallow forms, composed of sand cemented with carbonate of lime, and lined with small crystals of calcite, were observable, probably pseudomorphs after Celestine.

The base of this cutting is from 75 to 80 feet from the summit, and appears to be the lowest exposure of the Red Beds.

From this point there is a descent of about 50 feet down a bank of earth-sand, covered with fragments of gypsum, the result of the disintegration carried on up above to the Limestones or White Beds in which the quarries are.

From these notes it would appear that the characteristic feature of these upper or Brown Beds is the number of bands made up of fossil *Ostreæ*. At a short distance in many places these appear like a shale, and it is not until a close inspection is made that their real nature can be seen, which in some cases bears a striking resemblance to the beds of *Ostrea distorta* in our Purbeck series.

Imbedded with them are other shells, which may be easily detached; but the Oysters themselves are so matted and friable that it is difficult to obtain single specimens.

II.—*White Beds.*

F. These commence 125 feet from the summit of the hill, and lithologically are very similar down to the lowest point yet excavated, 225 feet still lower, the lower beds differing from those above them in perhaps being more compact and of a fine texture. In places the rock is visibly almost wholly made up of fossil remains, these being more apparent in the upper than in the lower beds.

7.—At 160 feet from the summit on the north side of the road there is a concretionary band of limestone, the nodules of which are discoidal, about the size of a potato, but not noticeably elongated.

On this level, which is that of the road marked C on Plan, Fig. 3, numbers of minute Nummulites are visible, together with species of *Echini*. This is also an horizon of the beds containing Celestine, specimens of which may be seen in radial forms imbedded in the white limestone. When they fill the chambers of some fossil, as a Nautilus, perfect, well-defined, and brilliant faces of crystals are to be seen,—the various forms and combinations of which are described in the paper already *referred to by Messrs.* Bauerman and Foster (ante p. 353).

G.8.—Lying along the line of the second road, in Plan marked B, are many blocks that have fallen from above, and are seen to be full of Celestine. Here the rock is more compact than above, and the fossil remains are not so distinct, with the exception of certain Crustacea, which are remarkably well defined, the species *Lobocarcinus Paulino-Wurtemburgensis* being very common. In the face of this scarp there is a noticeable yellow band, containing Oysters and Nummulites.

H.9.—The line of the lower road, marked A upon Plan, leads into the lowest part of the quarry, 350 feet from the summit. Celestine is also found here; but it apparently differs from that found above in being massive, one piece showing an exposed surface 1 ft. 9 in. wide, perfectly transparent, and of a light yellow colour,—no transparent colourless crystals or opaque bluish white stellar forms, like those described by Bauerman and Foster, being found.

About 12 feet up the face of this scarp there is a bed excedingly full of Nummulites, corals, and other fossil-remains, together with some remarkably well-preserved casts of a spiral shell, probably a a species of *Turbo*.

In travelling towards the north, in the direction of the Tombs of the Caliphs, owing to the dip of the beds in this direction, newer beds, corresponding to the second and third scarps of the Citadel Quarries, are met with, sections of which may be observed in the many valleys entering from the N.E.

Immediately outside the quarry in this direction numerous shark's teeth are met with, which are followed by large *Nautili* and other fossils. In the quarries behind the Tombs of the Caliphs Crustacea and casts of *Turbo* are again met with in abundance, beyond which, on crossing a small valley, you come to Jebel Achmar, or the Red Mountain.

Jebel Achmar.—This mountain or chain of hills is about 225 feet above Cairo. At a distance they appear to be very red; but on nearing them this is seen to be partially superficial, the exterior colour being due to an oxidation through exposure of the iron contained in the rock, which is a moderately fine-grained yellowish quartzose sandstone.

The texture, however, varies, portions having quite a conglomeratic aspect,—white quartz pebbles about a quarter of an inch in diameter being inclosed in a red base.

The fine parts of the rock are quarried for grindstones and millstones, which are manufactured in Cairo.

Petrified Forest.—This interesting deposit of silicified wood having been already described by Mr. W. Carruthers, F.R.S. (Geol. Mag. 1870, Vol. VII. p. 306), it will be well not to run over old ground, but rather to describe the road leading to the so-called "Forest," than to speak of the Forest itself.

Leaving the Red Hills upon the left, the track towards this Forest enters the second valley counted in the direction of the Citadel. crossing the entrance to which, and also running up it for a short distance, is a tramway for fetching stone.

The entrance to this valley is narrow, being bounded on the right and left by cliffs of limestone, which dip at a low angle up the valley, those on the right being about 50 feet in height, and those on the left from 20 to 30 feet. As the valley gradually widens, to a breadth of about half a mile, the cliffs and hills which form a scarp to it become lower. Covering the ground over which you walk are fragments of gypsum sparkling in the sand, as mica often does in the gravels of our streams, which probably indicate the presence at some point higher up the valley of the sand-beds seen above the Citadel Quarry. Opposite to the termination of the tramway, which is about half a mile up the valley, upon the right-hand side of the road, there is a knoll of black stones, in the distance something like a low volcanic cone. This is made up of a similar but darker coloured rock to that of Jebel Achmar, and in fact apparently marks the eastern boundary line of this red quartzose formation, which forms several outcrops, and appears to run up the right-hand side of this valley.

Keeping to the right hand at all junction of tracks, you pass along the foot of the limestone hills, whilst opening out upon the left there is a wide flat plain, which shortly narrows into a flat valley. Near the head of this, many black masses of quartzite, similar to the one just mentioned, are seen, covering portions of the hills. If a line were drawn passing through these heaps of débris, it would take a N.W. direction towards the Red Hills.

At the first of these mounds there is a ridge of the material, which is apparently turned on end, the left-hand side of which is quite a dark-coloured flint; whilst the right-hand side cannot be distinctly seen, from the quantity of débris which has fallen from above upon it, amongst which there are several large fragments of silicified wood.

Standing up from a sandy rock on the west or Cairo side of this ridge, there are a number of short cylinders, averaging six inches in length to one inch in diameter, formed of concentric layers of sand, the structure of which is seen in a transverse fracture.

Near the head of this valley, at the entrance to a small cutting into the hills upon the right, the relation of the limestones to one of these siliceous ridges is to be seen. This, like the others, strikes in the direction of the Red Hills, dipping at an angle of about 80° to the N.E., upon that side it is a fine-grained siliceous rock, from which it graduates in a thickness of only two feet through a pudding-stone, into a soft quartzose sandstone upon the N.E.

Coming down the cutting upon this side are some narrow bands of limestone, overlying beds of sand, also dipping to the N.E., but only at about 5° or 6°, which, but for the intervention of a few feet of sandy material, would apparently be seen to abut against the up-turned ridge.

A short distance beyond this last-mentioned ridge the track turns sharply to the right, and enters, between sloping masses of red rock, into a large opening, resembling a shallow sand-pit, above which is the *Petrified Forest.*

Generally speaking, this consists of fragments of silicified wood about six inches in length, which are strewn over about four miles of desert. Where the trunks from which they have been derived are shielded from the sun by lying buried in the sand, and have thus been protected from sudden changes of temperature, they are often preserved in pieces several yards in length. When fissured, they do so rather down the trunk than transversely to it, which would seem to contradict Gardiner Wilkinson's suggestion,[1] referred to by Mr. Carruthers,[2] that there are "some jointed stems resembling bamboo or *Equisetum*." In the same paper it is stated that no branches were observable, which appears to be the case; but I was assured on good authority that at the New Petrified Forest a tree with the limb of a large branch may be seen. The larger trees referred to may be seen by taking a S.E. course towards a distant bluff across this desert. After about a mile you reach the north end of a line of low sand and gypsum hills, keeping along the eastern side of which you shortly come upon numerous trunks lying in the sand, some of which are 40 feet long and two feet in diameter.

Beyond these, still continuing in a S.E. direction, through a gap in the low sand-hills, for a quarter of a mile across the next open valley, some extensive Oyster-beds are reached, from which some perfect specimens may be obtained.

On the opposite side of the Nile to that on which Cairo stands are corresponding hills to those of Moccattam, in which are the ancient quarries of Sattanah. At the Pyramids of Gizeh, which are built of Nummulitic Limestone, the Sphinx is seen cut out of the solid rock, and exhibits in the material composing it a natural N.E. dip and the eroding effects of tens of centuries of sand-blast.

V.—NOTE ON THE RED CHALK IN YORKSHIRE.

By the Rev. J. F. BLAKE, M.A., F.G.S.

IN mapping the boundaries of the Lias in that part of Yorkshire where the Cretaceous rocks overlap the Jurassic, the Red Chalk becomes extremely useful as a guide, especially as the springs constantly break out beneath it, and give good opportunities for its examination and that of the subjacent strata. Some points of interest have thus obtruded themselves upon one's notice. Its range in Yorkshire may be described as first northwards and then eastwards. Though much covered by Boulder-clay in the latter portion, it may be traced almost step by step along the former, except where it appears to be absent.

Mr. Judd[3] has drawn attention to the unconformity between the Upper Cretaceous and Neocomian series, with which latter beds he includes certain ferruginous pebbly beds which lie below the Red Chalk, and are generally unfossiliferous, but which contain towards the base, at Hunstanton, numerous *Ammonites Deshayesi*, which he also finds in the uppermost bed of the Speeton Clay. Mr. De Rance however,[1] records the same Ammonite as characteristic of the lowest beds of the Gault of Folkstone, where also it is associated with pebbly beds.

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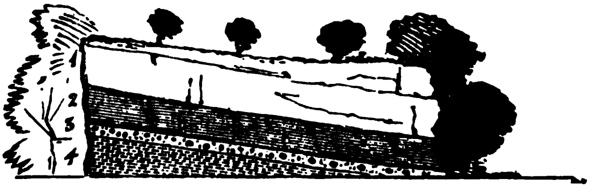
[1] Gardiner Wilkinson in "Murray's Handbook for Travellers in Egypt" (1867).

[2] W. Carruthers, "On the Petrified Forest near Cairo," *op. cit.* p. 307.

[3] *Quart. Journ.* Geol. Soc. vol. xxiii. p. 242, etc.

Remembering these facts, I think the following section, as seen in a plantation near Givendale Church, is of interest.



Section seen near Givendale Church, Ripon, W. R. of Yorkshire.
1. White Chalk. 2. Red Chalk. 3. Conglomerate. 4. Variegated Sandstone.

In Bed 2, in a matrix of undoubted Red Chalk, I found a characteristic specimen of *Am. Deshayesi*. The conglomerate is of smooth rounded black stones enveloped in a rather sandy matrix, contaminated apparently with Red Chalk, and the sandstones below are soft, and not unlike the carstones of Hunstanton. The section, however, is so small, and the sands unfossiliferous, that it cannot be certain whether or not these sands belong to the Middle Oolite. I think not, however; for though there are sands of that age in the district, they are not like this in appearance.

A little further north of the above is another interesting spot—though no clear section is exposed—in Garrowby Park. Beneath a clump of trees towards the head of the vale in which the house stands is a considerable thickness of Red Chalk, containing *Terebratula capillata*, *T. biplicata*, *T. semiglobosa*, *Inoceramus* sp., *Belemnites minimus*, etc., and at a little lower level are great blocks of conglomerate with sandy matrix, and below that a sand-pit. Here again the sand may belong to the Oolite, but the conglomerate which has now become an important rock must be associated with the Red Chalk. Hard gritty sandstone similar to the matrix of the conglomerate is also seen in neighbouring hill-sides, but not where the Red Chalk is at a distance. In a narrow gorge east of Kirby Underdale the Red Chalk is underlaid by some thickness of a very coarse gritty sandstone, which would be loose sand but for the binding action of iron, the oxide of which runs in fibres in all directions, and covers every grain. This deposit, too, seems to be quite local, and cannot be matched among the Oolites of the neighbourhood.

We have thus associated with the Red Chalk three different varieties of conglomeratic beds, passing into or being themselves more or less sandstones, which are not found in Oolitic rocks remote from the Chalk. It is worth consideration, therefore, whether they are not scattered patches of deposits formed in the irregularities of the older rocks. These conglomerates are no doubt littoral deposits, and the shore would contain hollows which would be filled from various sources, and these patches, it may be remarked, occur where there is irregularity in the lower strata.

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[1] Geol. Mag. Vol. V. p. 169.

Seeing that the Chalk is a deep-sea deposit, we have evidence of the sinking of the land in these Upper Cretaceous times, so that the passage-beds from the Upper Neocomian to the Aptien were laid down in various areas from various sources, and thus we have the great variety which characterizes these beds. But when the Red Chalk Epoch arrived, the depression was sufficient to enable that rock to spread pretty uniformly over a wide area, though not to be entirely without interruptions, as was the case with the White Chalk which succeeded; for there are gaps and varieties of level in the Red Chalk that may be better accounted for by an irregular surface than by faults.

Ammonites Deshayesi evidently lingered on during the time that the earlier of these changes were taking place, being the last to disappear at Hunstanton, lingering on in Yorkshire till the Red Chalk began, and at Folkestone, till the Gault set in. Thus the Red Chalk of Yorkshire represents the latter formation; but as it appears to have been an area of slow deposition, the few feet of it must represent the whole interval during which the Gault and Greensand were being deposited elsewhere, and the occurrence of the peculiar *Terebratula capillata* associates the basin with that of Hunstanton.

Mr. Judd mentions that in Lincolnshire there are beds of Red Chalk intercalated between two of White Chalk, with the true Red Chalk, or Hunstanton Red Rock, some 20 or 30 feet below. The same is the case in Yorkshire. Both beds may be well seen at the village of Warter, but their lithological characters are *generally* distinct; the upper beds are simply chalk coloured red; whereas the true Red Chalk with much of calcareous matter unites much of arenaceous, and small round grains are common of the same dark rock which furnished the older conglomerate. The rock, however, at Speeton, which contains *Bel. minimus* is of the former kind, so that the distinction, though common, is not universal.

While writing of bands in Chalk, I may as well notice a curious phenomenon seen in a chalk-pit near Londesborough. This is the existence, between beds of undisturbed chalk, of several stratified layers of brown carbonaceous clays between one and two feet thick, the bottom layer quite black and thinly laminated; all of them following the bends of the Chalk strata, the upper of which is perfectly stratified, though broken in small joints; the lower is more compact. This pit must have been near enough to land to be influenced by the deposit of some flood which carried off the soil of some Cretaceous forest. Mr. Mortimer mentions some clay-beds at Driffield, and Mr. Whitaker in the South of England in Chalk; but they are not said to be carbonaceous.

NOTICES OF MEMOIRS.

I.—A SHORT SKETCH OF THE GEOLOGY OF NASSAU.[1]

THE characteristic geological formations of the Province of Nassau belong to the Devonian series, and are named from the geographical site where they are most clearly developed, the Rhine System. The lower strata of this system are of a sandy character, and show in their fossil remains a predominance of Brachiopods (*Spirifera*, *Orthis*, *Terebratula*), and of these *Spirifera macroptera* occurs by far the most frequently, on which account Sandberger has classified the upper strata as the Spirifer Sandstone. Of other families of Mollusca, the *Pleurotomaria Daleidensis*, *Bellerophon trilobatum*, and *Conularia* (*Coleoprion*) *gracilis* are found in great numbers, but within a limited area. In Crinoidea the genus *Ctenocrinus* is peculiar to the Spirifer Sandstone, and fragments of the arms of these and of the genus *Isocrinus* are abundant. Crustacea are represented by the genus *Homalonotus*. *Pleuracanthus laciniatus* is the fossil most widely disseminated; but the *Pleurodictyum problematicum* must be regarded as the most characteristic in this group.

Contrary to the opinion of Murchison and Sedgwick (Geol. Trans. vol. ii. page 221), who are inclined to refer these beds to the Silurian system, the German geologists Sandberger and Römer regard them as a separate formation, approaching the chalky beds of the Rhine system more nearly in the character of their fossil remains. The superposed strata show a still more calcareous character, and have a far greater variety of fossil remains, corals, and gasteropodous mollusca. As characteristic species may be cited *Stringocephalus Burtini*, various species of *Pleurotomaria*, *Euomphalus*, *Terebratula*, and two Spirifers of a different species from those met with in the strata just mentioned. Among the Crustacea the genus *Cypridina* is most frequently represented, especially in the upper layers. The general character of the fauna point to an epoch in the formation of the land when the sea had retreated, leaving only inland lakes, on whose borders a new order of animal life could find a suitable habitat.

Above the sandy and chalky beds of the Rhine system lie a series of rocks, which resemble most closely the Coal-formation, both in their lithological character and their fossil contents. Especially is this the case with the flora. The fauna presents partly the same character as the limestone, and partly shows a new and entirely distinct facies. It is more fully developed in Westphalia, the Harz mountains, and in Devonshire. The fauna is not so manifold as that already noticed; the characteristic fossil from which the rocks are indeed named by German geologists is *Posidonomya Becheri*; *Pecten* and *Goniatites* are also found, but mostly in a very fragmentary condition. The remains of plants, on the other hand, are more numerous and better preserved. *Calamites Suckowii*, *Cyperites bicarinata*, and many other still undetermined species, frequently occur. A fern of the genus *Sphenopteris* is met with, but more rarely.

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[1] Being a brief abstract of Dr. F. Sandberger's recently published book on the Mineralogy and Geology of Nassau.

The strata just described are found in their fullest development on the ridge of the Taunus mountains, and its northward slope to the valley of the Lahn. On the southern slope of the range, towards the Main, and its junction with the Rhine, the Tertiary formations and alluvial deposits are considered to exhibit traces of the former existence here of a large inland sea, the Mayence Basin, which extended from Rudesheim to Bâsle. A sand-pit on the Biberich road, S.W. of Wiesbaden, affords a good opportunity for studying the beds of this group. The strata here lie in a nearly horizontal position, and show, after a layer of sea-sand and various chalky beds, regular alternations of fresh water and marine deposits, according to their mollusca, and lastly, a layer of coarse alluvial sand and gravel, rich in fossil remains. Besides a great quantity of mollusca (*Planorbis*, *Lymnæa*, *Cyclas*, *Helix*, and *Valvata*), all agreeing very nearly with existing species, the remains of mammalia occur here—*Elephas primigenius*, *Rhinoceros leptorhinus*, *Hippopotamus major*, *Ursus spelæus*, *Cervus euryceros*, etc. Fragments of tusks, and the fore-leg (tibia) of the first-named animal, have been brought to light this winter in the sand-pit just mentioned, where only a slight upper stratum of yellow sand has been deposited above the coarse gravel, which is here 20 feet deep. The remains all show traces of having been long exposed to the water, and are encrusted with yellow sand and calcareous matter, seemingly the remains of the shells of marine mollusca. The whole series of these Tertiary beds appears to be referable to the Miocene epoch, being more recent than the deposits of the Paris and London basins, but older than those of the Apennine range.

B. E. W.

II.—TRANSACTIONS OF THE GEOLOGICAL SOCIETY OF GLASGOW. Vol. iv. part 2, 1873.

THE contents of this part contain papers of much interest, and chiefly devoted to Scottish geology. Besides an abstract of the Proceedings of the Society for the year 1871–2, some of the papers read at these meetings are published in full, which, together with a biographical notice of the late Dr. Scouler, and the closing address of the President, Dr. John Young, "On Geological Terminology," form the bulk of this part. Glacial and Post-Tertiary geology, as in the preceding part, are prominent subjects, and a paper "On the Valley of Loch Lomond," in which the author, Mr. G. H. Kinahan, advocates similar views as to the origin of its form and the deeps and shallows of the lake, to those respecting the form of Loch Derg, given in this MAGAZINE (Vol. X. p. 486), and which he considers to be primarily due to breaks in the rocks.

J. M.

III.—BRIEF ABSTRACTS.

1.—LUDWIGITE; A NEW MINERAL SPECIES. Ludwigit, ein neues Mineral aus dem Banate. Von G. TSCHERMAK. *Mineralogische Mittheilungen*, 1874, Heft i. pp. 59–66.

This mineral occurs in limestone at Morawitza, in the Banat. It presents a finely-fibrous structure, the fibres being separated with difficulty, and the mineral being therefore very tough. In consequence of this fibrous texture, it is not easy to determine the precise degree of hardness, but it is probably about five. Dr. Tschermak describes two varieties of Ludwigite; the colour of the one being blackish-green, whilst that of the other is almost black, with a slight tint of violet. Both varieties have been analyzed under Prof. Ludwig, of Vienna, after whom the species is named.

No. I. is the green variety, with specific gravity 3·951; No. II. is the black variety, with spec. grav. 4·016.

	I.	II.
Boric anhydride	16·09	15·06
Ferric oxide	39·92	39·29
Ferrous oxide	12·46	17·67
Magnesia	31·69	26·91
	100·16	98·93

The second analysis leads to the formula: $3\,MgO \cdot B^2O^3 + FeO \cdot Fe^2O^3$. The first analysis shows part of the ferrous oxide isomorphously replaced by magnesia. It appears, therefore, that Ludwigite is a molecular combination of borate of magnesia with proto-peroxide of iron; the latter compound does not exist mechanically disseminated through the mineral in the form of magnetic iron-ore, but appears to be chemically combined with the borate. F. W. R.

2.—RIVOTITE; A NEW MINERAL SPECIES. Note sur une nouvelle espèce minérale de la Province de Lerida. Par M. X. DUCLOUX. *Comptes Rendus*, 1874, lxxviii. No. 21, pp. 1471–1473.

Under the name of *Rivotite*—a name proposed in memory of the late M. Rivot, of the Ecole des Mines—a new Spanish mineral is described by M. Ducloux. It occurs in small irregular masses disseminated through a limestone, on the western slope of the Sierra del Cadi, in the province of Lerida. Rivotite is a compact amorphous substance, varying in colour from yellowish green to dark greyish green. Its hardness is between 3·5 and 4, whilst its specific gravity varies from 3·55 to 3·62. According to M. Ducloux, the composition of Rivotite may be expressed by the following formula: $Sb^2O^5+4(Gu,Ag)O.Co^2$. F. W. R.

3.—ON DATOLITE. Ueber Datolith. Von EDWARD S. DANA. *Mineralogische Mittheilungen*, 1874, Heft i. pp. 1–6.

Two years ago Mr. Dana published in *Silliman's Journal* a paper on the crystallographic characters of the well-known crystals of Datolite from Bergen Hill. He has since extended his study of this species, and has examined a fine series of specimens in Vienna. The results of this work are given in the present paper, which relates chiefly to the Datolite of Arendal in Norway, Andreasberg in the Hartz, and Toggiana in Modena. The occurrence, the symbols, and the angles of all the known faces are exhibited in a well-arranged table; whilst several figures of crystals are given in a lithographic plate accompanying the paper. F. W. R.

4.—Tawney, E. B. Museum Notes—Dundry Gasteropoda. *Proc. Bristol Nat. Soc.*, new series, vol. i. part i. pp. 9–59. [1874.]

This communication is the result of a critical examination, by Mr. Tawney, of the Gasteropoda, now in the Bristol Museum, which have been obtained from the Inferior Oolite of Dundry Hill. He records sixty-six species in a determinable condition, besides casts and imperfect fragments of shells. Of the genus *Pleurotomaria* alone there are twenty-six species.

Out of the total number of species, no less than nineteen do not appear to have been hitherto figured, and fifteen species do not seem to have been cited before in British lists. The paper is illustrated by three well-executed lithographic plates. H. B. W.

5.—Tawney, E. B. The Coal Question. *Proc. Bristol Nat. Soc.*, new series, vol. i. part i. pp. 71–84. [1874.]

The author reviews the general results of the Royal Coal Commission, and discusses the future prosperity of England. H. B. W.

6.—Stoddart, W. W. Geology of the Bristol Coal-field. Part I. *Proc. Bristol Nat. Soc.*, new series, vol. i. pp. 115-126. [1874.]

This part contains a general account of the physical geography of the district, with list of formations and typical localities where they are displayed, list of principal altitudes, etc. Mr. Stoddart refers also to the igneous rocks developed in the neighbourhood of Tortworth, on the Mendip Hills, and near Weston-super-Mare.

H. B. W.

7.—Thomas, J. E. Prize Essay upon the Mineral Resources of the Counties of Flint and Denbigh, with suggestions for their development. (Mold National Eisteddfod, 1873.) 8vo. pp. 41. (Oswestry, 1873.)

The author describes the geological features of the district, and points out the mineral produce of each system of rocks. He then considers the resources of Coal, Lead, and Zinc more in detail, the extent to which they have been developed in this part of North Wales, and their present yield, glancing also at the future supplies that, it is to be hoped, may continue to be produced for many generations to come. In conclusion he gives a list of various collieries, iron works, lead mines, brickworks and quarries in the two counties. H. B. W.

REVIEWS.

◆

I.—Reports of the Geological Survey of the State of Missouri, 1855–1871. By G. C. Broadhead, F. B. Meek, and B. F. Shumard. (Jefferson City, 1873.)

THE publication of this volume appears to have been delayed, for the maps were engraved, and the impressions contained in the volume were struck off, previous to 1861, so that they do not represent the present political geography of the respective counties, and in some instances their boundaries have changed.

The State of Missouri is divided into twenty counties, and each one is treated under three principal heads, viz. the Topography, Scientific and Economical Geology. The formations which occur in the State are the following:—

QUATERNARY.—Alluvium, Bottom Praries, Bluff, and Drift.

CARBONIFEROUS.—Coal-measures, Ferruginous Sandstone, Archimedes, Encrinital and Chouteau Limestones.

DEVONIAN.—Upper and Lower.

UPPER SILURIAN.—*Delthyris* shale or Lower Helderberg, Niagara group, Cape Girardeau Limestone.

LOWER SILURIAN.—Hudson river group, Trenton Limestone, Black river Limestone, Magnesian Limestone series, consisting of four zones of Magnesian Limestone, with alternating zones of Saccharoidal and other Sandstones.

The Lower Silurian and Quaternary rocks are found in most of the counties, the Coal-measures are not so generally distributed, they are the only Palæozoic rocks seen in Macon, occupy nearly the whole of Randolph, about one-third of Saline, probably nearly one-half of Clark county, and are sparingly distributed in Morgan, Warren, and Shelby counties. Igneous rocks are not abundant; Granite is found in Crawford and Ste. Genevieve, in which latter county Greenstone has also been noticed. The maps and sections in the volume illustrate to some extent the geological descriptions in the reports. J. M.

II.—GEOLOGICAL SURVEY OF MISSOURI. PRELIMINARY REPORT ON THE IRON-ORES AND COAL-FIELDS FROM THE FIELD-WORK OF 1872. (New York, 1873.)

THIS volume of more than 600 pages contains a careful and detailed description of a portion of the economic geology of the State, bearing specially on the Iron-ores and Coal-measures. The first part is chiefly occupied with the distribution, description, and modes of occurrence of the Iron-ores by Dr. Adolf Schmidt. Rich, even the richest as Missouri is of all the States on the North American continent in Iron-ores, they are very unequally distributed over the State. Very little is found in the whole northern part north of the fiftieth township line, and in a range of counties on the western border; these districts covered by Coal-measures do not contain Iron-ores in such quantities as to make them workable.

Workable Iron-ore is found in Calloway county, north of the Missouri river; and south of it, between this river and the fortieth township line, valuable deposits occur, mostly of Limonite, in Franklin, Osage, Morgan, and Benton counties. By far the richest portion of the State in Iron-ores is that between the 30th and 40th township lines; they abound within this zone, in the greater part of the counties situated between the Mississippi on the east, and the Upper Osage river on the west. The chief ores are Specular iron, sometimes a little magnetic, Red Hæmatite, and Limonite. This part also contains analyses of Fuels, Iron-ores, and Pig-irons, by MM.

Regis, Chauvet and A. A. Blair, and also Notes on the Geology of Pilot Knob, by Prof. R. Pumpelly, the Director of the Survey.

The second and larger part contains Reports on the Geology of Different Countries of North-western Missouri, by G. C. Broadhead, State Geologist, including five chapters on the Missouri Coal-field, from which it appears that the Coal-measures of this State comprise an area of about 23,000 square miles, chiefly situated in North-west and Western Missouri, but including 160 square miles in St. Louis, eight in St. Charles, and a few outliers in Lincoln and Warren counties. They are divided into Upper, Middle, and Lower Coal-measures; the Upper or barren Measures, which contain the thickest groups of limestones, occupy about 8000 square miles, have an aggregate thickness of 1300 feet, and include only about four feet of Coal, of which there are two seams of one foot in thickness; the others are very thin seams or mere streaks. The Middle Coal-measures are exposed for about 2000 square miles, and include a total thickness of 324 feet, in which are embraced about seven feet of Coal, including two workable seams of 21 and 24 inches, one other of one foot, and six seams too thin to work. The Lower Measures, mainly composed of sandstones and shales, are exposed over 12,400 square miles, are from 250 to 300 feet thick, embracing about five workable seams of Coal, varying in thickness from 1½ ft. to 4½ ft., which, together with other thin seams and streaks, make in all 13 ft. 6 in. of Coal. So that in Missouri it appears there is about 2000 feet of Coal-measures, with a total aggregate of 24 ft. 6 in. of Coal. The volume contains nearly 200 illustrations, besides a report on the Strength of Building Materials, Notes on Rocks which admit of a polish, a List of the Fossils of the Coal-measures, a Schedule showing depths of Coal-seams, and is accompanied by a large Atlas of 14 plates, illustrative of the geology and other matters referred to in the Report.

J. M.

III.—REPORT ON THE GEOLOGICAL SURVEY OF OHIO. Vol. I. Part II. pp. 400. 48 Plates. (Columbus, 1873.)

THE present volume contains the first part of the Palæontological Report of the Geological Survey, and according to Dr. Newberry, the Chief Geologist (under whose auspices it is issued), the first illustrated memoir ever published on the fossils of the State, so rich as it has long been known to be in beautifully preserved specimens from the Silurian, Devonian and Carboniferous strata. Besides the Preface, Dr. J. S. Newberry contributes an elaborate memoir on the classification, geological and geographical distribution of the fossil fishes found in the Palæozoic rocks of the State, with detailed descriptions of the new or little known genera and species, including a very large *Placoderm* (*Dinichthys*) allied to *Asterolepis*, and also notices of some few of the fossil plants of the Coal-measures of Ohio, as *Cardiocarpon*, *Trigonocarpon*, *Rhabdocarpus*, and a new genus of ferns, *Neriopteris*, related to *Tæniopteris*, but which appears to have some resemblance to the Jurassic genus *Stangerites*. In the section on the origin of our Ichthyic fauna, Dr. Newberry remarks that in

America the first remains of fishes are found in the Corniferous Limestone, where they appear in great force, consisting of several genera and species, some of which attain gigantic dimensions. Of the origin of this fauna we know nothing, and probably never shall know much. With the Devonian seas in their retreat, departed all the group of great bucklered fishes, never more to return. In the sea of the Carboniferous age, sharks abounded in great numbers; along the shores, and in the lagoons and rivers of the Coal-measure epoch, a multitude of Ganoids abounded; in the same strata and localities, another and higher class of vertebrates, the Amphibians, have left abundant remains. The Ganoids shade so gradually into these Amphibians, that it is impossible to draw any well-defined line between them. And there is little doubt that a connected chain of being leads from the Ganoids through the Amphibians up to the true Reptiles. With the retreat of the Carboniferous sea, most of the interval between the Mississippi and the Atlantic was left dry land, and has never since been submerged. On this land, or the lakes and rivers of the Canadian continent, which has remained as land since a period anterior to the Silurian age, the Ganoids of the Coal-period have continued to exist, and in our *Lepidosteus* and *Amia* we probably have the lineal descendants of *Palæoniscus*, *Cœlacanthus*, etc., of the Carboniferous age (p. 289). A great portion of the volume is occupied with the description of the Invertebrate fossils by Mr. F. B. Meek, the well-known palæontologist, and for some years connected with the Illinois Geological Survey. The work is further illustrated by 48 well-executed plates of the fossils, and although many of these beautifully preserved forms from the rich localities near Cincinnati had previously been described by Professors Hall, Winchell, Meek, and others, yet this appears to be the first collected systematic description of the fossils of the State of Ohio. J. M.

REPORTS AND PROCEEDINGS.

COTSWOLD NATURALISTS' FIELD-CLUB AT BATH.

ON Thursday, June 25th, by invitation of Handel Cossham, Esq., F.G.S., the Cotswold Field-club met at Weston, near Bath. The programme for the day included an examination of the Rhætic and Lower Lias sections near Weston; of the Coal-sinkings near Pennycuick Bottom, the most easterly point of the Bristol Coal-basin; the ascent to the Great Oolite plateau at Odd Down, and descent thence to the Midford valley, for the purpose of examining the "Midford Sands," returning to Bath by way of Beechen Cliff.

A party, nearly fifty in number, assembled at the Weston Station on the arrival of the 12.32 train, and proceeded at once along the line of rail to examine a quarry and section about a quarter of a mile distant. At the quarry Mr. C. Moore drew attention to a band of shale or marl overlying the thickly-bedded rocks of the "Bucklandi" zone, as marking a special horizon and as traceable in all the Lias quarries throughout the district. This band indicates a change in the character of the deposition which is marked by the presence of a peculiar fish-fauna, as evidenced by the occurrence therein of teeth of *Hybodus*, *Acrodus*, *Leptolepis*, and *Dapedius*. The section next visited—a wide open clearing—presents one of the finest and most characteristic expositions of the White Lias in the district. This section embraces the whole series of beds from the "Keuper" upwards. The "Bone-bed" does not occur on any special horizon, but is distributed over several different beds. The "White Lias," about twelve feet thick, rests on the "Cotham Marble," or "Landscape Stone," which is about a foot in thickness. At the top of the Lias occurs the so-called "Sun-bed" of William Smith, above which are the beds of *Ostrea liassica*. The "Planorbis" zone is here absent. A list of the organic remains from the Weston quarries is given in Mr. Moore's paper on Abnormal Secondary Deposits in the Quarterly Journal of the Geological Society for 1867, vol. xxiii. pp. 449–568.

After luncheon, which was provided by Mr. Handel Cossham, the party proceeded in carriages by way of Cross Post Gate and Twerton to Pennycuick coal-pit. At this point a shaft is sunk through the Lower Lias to a depth of about 160 feet. The beds of coal to be reached are those of the lower coals of the Bristol basin, on the extreme edge of which the shaft is made. The coals being sought for on the edge of a "fault" will probably prove to be much broken and of inferior quality. From Pennycuick the carriages ascended the steep hill, by the Old Foss way, and passed over the Inferior Oolite and "Fuller's Earth" beds to the plateau of the Great Oolite at Odd Down (ascertained by aneroid to be 450 feet above the Avon at Bath), and descended on the other side into the valley of Midford, where the new line to Evercreech was in process of construction. Here an excellent section was presented, cut out of the "Midford Sands" of William Smith, and by him considered to occupy the place of the Upper Lias—a wonderful example of the diagnostic faculty of the "Father of English Geology," which later and more exact knowledge has confirmed. These beds are doubtless the equivalents of the "Upper Lias Sands" of Frocester Hill, and are overlaid at this point by the Trigonia Grits of the Parkinsoni Zone, representing the highest beds of the Inferior Oolite; the Oolite Marl and all the subjacent beds (200 feet thick) being absent: and this is found to be the succession of the beds throughout the Bath district.

It was now time to commence the return journey, and at four o'clock the party assembled at Mr. Cossham's new residence at Weston Park, where about fifty sat down to a sumptuous entertainment provided by their kind and generous host, this being the third successive year in which the Cotswold Club has partaken of the same splendid hospitality. Dinner being over, Dr. Wright was called upon by the President to read his promised paper on "The Genesis of the Oolites." This paper was deferred at the previous meeting of the Club through want of time to read it; and even on the present occasion the time was so restricted that Dr. Wright was constrained to compress within the limits of half an hour an address which needed more than double that time for its due elaboration. The lecture was illustrated by excellent and beautiful sections and figures. The author commenced by saying that this subject had long occupied a place in his thoughts, and that only of late it had gathered such form and consistence as would permit him with confidence to put it forward. He had long been persuaded that without an intimate knowledge and study of the structure of the *Zoophyta*, it was not possible to comprehend the incalculable importance of those obscure creatures in the seas of ancient and modern times. He briefly described the anatomy of the "Sea Anemone" as typical of a large section of these Zoophytes, and pointed out the difference between those which have no calcareous skeleton like the Anemone, and those which build coral structures or reefs in tropical seas, the calcareous material whereof they are constructed being derived from the water of the ocean; and by colonies of these tiny architects working in unison, structures of gigantic proportions are produced. The lecturer then showed how that the reef-building corals can only live and work in water, having a temperature of from 80° to 82°; and as that condition is now chiefly found between 30° north and south of the equator, their operations are for the most part confined within those limits; while even in those latitudes where the ocean is traversed by cold currents, there zoophytic life is absent. He then explained that in certain areas of the earth's surface, one portion is subsiding while others are rising; that observation had shown that the Coral Sea of our time is a vast area of depression, and that the life-conditions within that area being very favourable to the development of Zoophytes, there was a prodigious growth of reef secretion; that when they built around land it formed a "fringing reef"; when that land underwent a further subsidence, the zoophytic structure became a "barrier reef"; and that when the land became entirely submerged, rings of coral, "Atolls," like Whit-Sunday Island, alone remained to attest the former presence of terra firma. He then explained how the waste of the reef is ground into a fine mud or into a coralline sand, that the calcareous paste coats particles of sand which become cemented around the nucleus, and how by the constant roll and agitation of an ever restless sea these physical conditions lead to the production of Oolitic Limestones which are found around the shores of the coral islands of our own time. Having thus established the fact that Oolitic Limestones are produced under the conditions just described, he proceeded to apply this natural history fact to an explanation of what had not yet been attempted, namely, the genesis of the Oolitic rocks, some of which they had seen that day. He said that the Oolitic series of rocks may be generally described as a succession of argillaceous deposits, as the Lias, Oxford Clay, and Kimmeridge Clay, with interposed beds of Oolitic rock, such as the Inferior Oolite, the Coralline Oolite and the Portland series; that the coralline theory applied only to the Oolitic Limestones, for the argillaceous deposits have clearly been formed under other conditions.

Nearly all the Oolitic Limestones contain coral structures more or less extensive; in the Inferior Oolite were three distinct reefs superimposed on each other, having intermediate beds of Oolite rock; the Great Oolite had its reef; the Coral Rag possessed its reef; and the Portland beds contained Zoophytic productions in like manner. Now there was no doubt in the mind of any one who saw such a rock as he (the lecturer) held in his hand but that it was a mass of coral secreted by a Jurassic Zoophyte. But what was the roe-stone or Oolitic rock which rested upon the reef? He submitted that it was nothing more nor less than a portion of the wasted reef, which had been broken and triturated and ground into mud; that the paste had coated particles of sand, and the whole had been cemented by the calcareous waters and formed into the rock we call Oolitic Limestone. For all these granules had a nucleus, and the calcareous globule was made up of a succession of laminæ, as may readily be seen in thin sections of the rock prepared for the microscope. So the genesis of the Oolitic rocks was due to the vital energies of the Zoophytes that lived in the Jurassic seas. The reefs that remained were mere fragments of those which had once existed, and the reefs that had disappeared had furnished the materials out of which the Oolites had been constructed. The same explanation would apply to the Oolitic beds found in the Carboniferous Limestone, which had been formed by the waste of the Coral beds in the Carboniferous seas. But the Oolitic grains of the Carboniferous Oolites had often a small foraminiferous shell as their nucleus, instead of the particles found in the Jurassic Oolites; but in both cases the process of production was the same; the granules had been rolled along a shore and cemented into rock by a calcareous cement, just as Oolitic beds are now in process of formation along the shores of the coral reefs of our own day. There was only one true method to interpret nature, and that was to watch how she proceeded in any of her operations, and thus, having learned her *modus operandi*, to explain the unknown by the known. There was another point connected with this subject which the lecturer glanced at, namely, the subject of geological time, which he illustrated by showing how that all these reefs in the different Oolitic rocks had been built by different species of Zoophytes, and as the life of individual species was of long duration, as proved by the Zoophytes which construct the reefs in the Gulf of Florida, so then the life of the species in the Jurassic age, if they lived as long then as they do now, justified the inference that the genesis of the Oolites was a very old and a very long story indeed. Dr. Wright exhibited a beautiful enlarged drawing by his friend Mr. Beach, who had prepared it from an illustration by Professor Heer, showing the ancient physical geography of the land with its plants and animals in the Jurassic sea.

Dr. Wright was greeted on the conclusion of his address with loud and hearty applause, and thanks were returned by the President and others for the new light which his explanation threw upon the important question of rock formation—a problem which this paper has done much to solve.

The President, in the absence of Professor Dyer, read a paper by that gentleman on "Clayey Partings in the Cotswold Oolites." The observations contained in this paper were directed to the composition of the clay in these fissures, and a comparison was instituted between the chemical constituents of the clay in question and that found under somewhat similar conditions in the Bahama Islands.

Mr. Moore said this was a physical and not a chemical question. He had been engaged for many years in investigating the nature and contents of these vertical fissures in the Cotswolds, and the results of his inquiries, which had been interrupted by ill-health, had proved of a very remarkable and unexpected character. He found in these fissures evidence of both marine and freshwater action. Of the former, in the presence of portions of a Cirripede (*Pollicipes*); and of the latter in the presence of land and freshwater shells, bog iron-ore, and bones and teeth of *Arvicola* in great abundance.

Mr. Etheridge quite concurred with Mr. Moore in the opinion relative to the physical rather than the chemical origin and condition of the clays filling in the joints and fissures. He had with Mr. Lucy carefully examined the condition of the clays in question and the numerous pebbles found in them, and attributed them to the time when the Cotswolds were under water. This was confirmed by the remains of *Pollicipes* and other forms found by Mr. Moore in the clay of the fissures.

With the reading of this paper the day's excursion closed.—*Gloucester Journal.*

GEOLOGICAL SOCIETY OF LONDON.—I. April 29, 1874.—John Evans, Esq., F.R.S., President, in the Chair. The following communications were read:—

1. "On the Gault of Folkestone." By F. G. H. Price, Esq., F.G.S.

The author divided the Gault into two great sections, Upper and Lower Gault, which he again subdivided into eleven well-defined zones, mostly named after characteristic Ammonites. Each of these zones or beds is numbered, commencing with No. xi., the zone of *Ammonites interruptus*, which bed forms the base of the Gault, reposing upon the Folkestone beds of the Upper Neocomian.

He found the thickness of the deposit at Copt Point to be 99 feet 4 inches.

He had collected as many as 228 species from the beds, including the following new species:—*Avellana pulchella*, *Natica obliqua*, and *Nucula De Rancei*, which he described.

The paper was accompanied by a table of species, setting forth the various beds in which the particular fossils have been met with.

2. "On the Cretaceous Rocks of Beer Head and the adjacent Cliff-sections; and on the relative Horizons therein of the Warminster and Blackdown Fossiliferous Deposits." By C. J. A. Meyer, Esq., F.G.S.

The author remarked that in advancing westward from the Isle of Wight the Cretaceous rocks diminish steadily, although unequally, in thickness, and change slightly both in mineral character and fossil contents, while the base of the series rises gradually in the cliff-sections. The chalk cliffs of Beer Head, the most westerly chalk promontory in England, owe their preservation, in his opinion, partly to a local synclinal arrangement of the strata. The Cretaceous rocks of the district include the following, in descending order:—

Upper Chalk (in part)?
Medial Chalk.
Lower Chalk.
Chalk Marl.
Chloritic Marl.
Upper Greensand.
Gault.
(?)

The author described in detail the minor subdivisions of these series, and gave lists of the fossils found in them *in situ*. The base of the section is occupied by beds, which he identified with those of Blackdown, certainly underlying the Upper Greensand, and apparently occupying the position of the Gault or of the Gault and Upper Neocomian in part. The Warminster beds, on the contrary, were said to cap the Upper Greensand, and to be in reality Chloritic Marl. The author suggested that the term Upper Greensand should be applied exclusively to beds between the Gault and Chloritic Marl, and that the latter should be considered a distinct division.

DISCUSSION.—Mr. Wiltshire remarked that the various beds were frequently divided by lines of nodules, especially towards the bottom, and that these nodules had definite forms in the different belts, in some being all rounded, in others radiate. He thought it very desirable to ascertain the reason of this. With regard to *Ammonites rostratus*, he stated that its aperture was beaked in the young as well as in the adult state, and remarked that information as to its mode of growth, and especially whether the successive beaks were absorbed, would be of much interest. The Blackdown beds he correlated with the lower part of Mr. Price's subdivisions. He also referred to the unexplained fact that a bed at the base of the Gault contains both shells and casts.

Mr. Carruthers referred to the discovery in the Gault of Folkestone by Messrs. Gardner and Price of cones belonging to two species of *Sequoia*, and associated with these some species of *Pinus*, two of which were to be referred to a group of that genus at present found associated with the two existing species of *Sequoia* on the mountains of western North America. These *Sequoiæ* from the Gault are the oldest known representatives of the genus; and it is remarkable that they should be thus early associated with species of the same group of Pines which is now represented only in the same country where the *Sequoiæ* also grow. Mr. Carruthers believed this to be the earliest trace of the geographical distribution of plants which now exist on the surface of the earth.

Mr. Topley remarked that the lithological and stratigraphical break between the Gault and the Neocomian is less marked than is generally supposed. At a place near Folkestone the lithological difference is so small that it becomes difficult to say where the one ends and the other begins. At Folkestone the highest beds of the Neocomian are false-bedded sands; and, contrary to what might be expected, these sands are the most constant of the series, always occurring where the Neocomian is represented below the Gault. As the Gault is traced westwards, we come to places where it is difficult to discern any difference between it and the Neocomian. He stated that Professor Way had found the exterior of the nodules to contain more phosphate of lime than the interior, which seemed to indicate that the phosphate came from without.

Mr. Charlesworth doubted whether the fossil egg, if that of a Crocodile, could be that of a living species. With regard to the forms of nodules, he remarked that in the Crag the nodules round the fang-like bases of sharks' teeth were more or less globular; and he did not think that the form of nodules has any relation to that of the nucleus around which they may have been aggregated.

Mr. Hawkins Johnson considered the nodules to be due to organic structures, probably sponges, which had grown upon a hard bottom, and afterwards been affected by its mineral constituents.

Mr. Teal inquired whether the nodules at the base of the Gault had been rolled.

Mr. Seeley having examined the supposed Crocodile's egg, declared that from its form it could not be that of a Crocodile, and he did not think it was that of a Turtle. It might possibly be the egg of an *Ichthyosaurus* or *Plesiosaurus*. He stated that he had found nodules of different forms scattered indiscriminately in the Gault, and that his investigations led him to believe that all these nodules had been subjected to wear and tear before coming into their present position. The subdivisions of the Gault recognized at Folkestone would not, he thought, be represented elsewhere; for their mineral characters were found to change greatly towards the west, the Gault itself becoming more sandy and micaceous as it approaches the granitic rocks. He believed that the Blackdown beds represented both the Greensand and the Gault.

Professor Hughes thought that we should take as the base of the Lower Cretaceous Series the first marine beds which succeed the freshwater deposits of the S.E. of England and rest on the Trias and older rocks in the S.W. He considered them to be deposits formed during a considerable period, as successive parts of an irregular land-surface were being depressed below the sea; so that a shore deposit might be formed at Blackdown while fine sand or clay was being thrown down further out to sea over that part of the S.E. of England which had already been submerged to a considerable depth.

Professor Ramsey observed that the value of such detailed sections, in a palæontological point of view, was very great; and with respect to the physical relations of the Gault and Upper Greensand, he stated that in some parts of England there is lithologically no clear line of demarcation between the two formations; and in like manner in some other areas there is no very definite boundary line between the Upper Greensand and the Chalk. He then drew attention to the views originally advanced by Mr. Godwin-Austen, who showed that in this part of the world all these Upper Cretaceous formations were deposited over a great continental area that was being slowly submerged, so that while the Upper Greensand began to be deposited in the sea in one area much of the land still stood above water, and as it got depressed these Greensand strata were gradually deposited on the sinking land. For this reason the two ends, so to speak, of a long section of the Greensand will be of somewhat different age; and while the end nearest the land was being deposited as sand, further out at sea true Chalk was being formed, and thus much of the Upper Greensand may be considered to have been formed contemporaneously with much of the Lower Chalk under different local conditions of proximity of land and depth of water.

Mr. Blake believed that the animal of *Ammonites rostratus* may have lived outside its shell.

Mr. Price stated that he did not wish to imply that the divisions indicated in his paper would hold good over wide areas. He added that bones of Turtle were not unfrequent in the Gault.

Mr. Meyer said that the division between the Gault and Greensand was not distinct. The Beer stone deposited in a hollow to the westward exhibited a change of texture. The upper beds of the Lower Greensand of Folkestone represent a lower horizon of the Lower Greensand at Guildford.—This was the last Meeting held in the old apartments of the Society in Somerset House.

II.—May 13th, 1874.—Opening meeting in the New Rooms of the Society in Burlington House.—John Evans, Esq., F.R.S., President, in the Chair.—The following communications were read:—

1. "Note on some of the Generic Modifications of the Plesiosaurian Pectoral Girdle." By Harry G. Seeley, Esq., F.L.S., F.G.S.

The author stated that Plesiosauria differ from all living reptilia, except Chelonians, in wanting a sternum, and pointed out the resemblance between the plesiosaurian coracoid and the coracoid and precoracoid of Chelonians, inferring that the plesiosaurian scapulæ had been carried *forward* by the potential ossification which elongated the plesiosaurian neck. He compared the chelonian plastron with the plesiosaurian girdle-bones, to show the dependence of form in the chelonian type upon the potential energy due to the conditions of locomotive activity, and used this consideration in elucidation of chelonian and plesiosaurian resemblances and differences. The plesiosaurian interclavicle he regarded as homologous with the chelonian and lacertian interclavicle; but the chelonian clavicles he believed to be epiphysial, potential representatives of the precoracoids, and therefore bones of which no analogues should be sought in Plesiosaurs on the theory of their chelonian affinities. He believed that the clavicles were occasionally distinct from the interclavicle, though usually blended with it, just as all these ossifications become obliterated by scapular extension.

The restorations and interpretations of the plesiosaurian pectoral girdle given by Conybeare, Hawkins, Owen, Huxley, Cope, and Phillips, were discussed, and reasons given for dissenting from their views. The old genus *Plesiosaurus* was divided into two families, the Plesiosauridæ, containing the genus *Plesiosaurus*, and the Elasmosauridæ, with *Eretmosaurus*, *Colymbosaurus*, and *Murænosaurus*.

A new type was taken for the genus *Plesiosaurus*, which showed distinct clavicles. *Eretmosaurus* has neither clavicle nor interclavicle, and the scapulæ, concave in front, are blended in the median line, and blended laterally with the coracoids. Its type is *Plesiosaurus rugosus* of the Lias. *Colymbosaurus* has for its type *Plesiosaurus megadeirus* of the Kimmeridge Clay. It has no interclavicle, the scapulæ are prolonged forward in a wedge and backward, so as to meet the coracoids in the median line, and enclose two coraco-scapular foramina.

Murænosaurus is founded on a new type from the Oxford Clay. It has no interclavicle, but the scapulæ are prolonged forward to meet in the median line; they are not prolonged backward to meet the coracoids, hence but one coraco-scapular foramen is formed. A similar condition marks the pelvic girdle.

2. "*Murænosaurus Leedsii* (Seeley), a Plesiosaurian from the Oxford Clay."—Part I. By Harry G. Seeley, Esq., F.L.S., F.G.S.

All parts of the animal, except teeth, ribs, and hind limbs, were described. The premaxillary bones extend bird-like between the nares to the frontals. The foramen parietale is between the parietal and frontal, and directed backward. The cerebral lobes of the brain have a chelonian form, are prolonged in olfactory nerves, like those of *Teleosaurus*, and have the optic lobes moderately developed. The exoccipital bones do not enter into the occipital condyle. The basisphenoid is perforated by the carotids, as in *Ichthyosaurus*. The hypoglossal nerve does not perforate the exoccipital bone.

There are 44 cervical, 3 pectoral, 20 dorsal, 4 sacral, and the first 8 caudal vertebræ preserved. Atlas and axis are anchylosed. The zygapophyses are semicylindrical, being concave in front and convex behind. A process of the neural spine is prolonged between the anterior zygapophyses, so as to divide the posterior zygapophyses and lock between them. The caudal vertebræ have the facets for the chevron bones free from the articular margins, forming large prominent unequal tubercles on the base of the centrum. The coracoids are as broad as long, nearly square, not prolonged in front of the humeral articulation. The scapulæ are sickle-shaped, thin towards the median line, and without any suprahumeral process. The pubic bones are transversely oblong, and the ischial bones more than usually triangular, owing to there being no forward prolongation to meet the pubes. The iliac bones are less expanded at the proximal end, and relatively longer than usual. In the limbs the ulna and radius approximate in form to those bones in *Pliosaurus*, and the phalanges resemble those of *Pliosaurus* in not being compressed from side to side. There are six polygonal carpal bones.

DISCUSSION.—Mr. Hulke said that it was only with great diffidence that he ventured to speak on the anatomy of Plesiosaurs. He urged that a suspension of judgment was desirable, as many points in the anatomy of these Saurians are but imperfectly known, seeing that bones which are displayed in one specimen may be concealed in the matrix in another. He thought that two types might be recognized among Plesiosaurs,—one with the coracoids extended longitudinally, the other with those bones transverse.

Mr. Charlesworth regretted that the Palæontologists who had specially written on the subjects treated of by Mr. Seeley were not present, and thought that the author was rather too dogmatic in his tone. He suggested that the distribution of casts of typical specimens to different museums would be of great advantage.

Mr. Seeley stated that he had endeavoured privately to bring his own views into harmony with those of other writers; and having enjoyed some facilities for arriving at the precise meaning of Prof. Owen's determinations, he wished to express his sense of that gentleman's generous appreciation of modern scientific progress and discovery. He believed that the apparent difference of his own determinations from those of previous writers was due rather to indecision of determination and absence of evidence for the purpose of determination in former times than to any fundamental differences between himself and others.

3. "On the Remains of *Labyrinthodonta* from the Keuper Sandstone of Warwick, preserved in the Warwick Museum." By L. C. Miall, Esq. Communicated by Prof. Huxley, F.R.S., F.G.S.

In this paper the author first noticed the remains of Labyrinthodonts from the Warwickshire Keuper, acquired by the Warwick Museum since 1842, the date of Prof. Owen's memoir on this subject, and then reviewed the determinations of Prof. Owen. He considered that *Labyrinthodon ventricosus*, Owen, is not a distinct species, and that *L. scutulatus*, Owen, has not been proved to be a Labyrinthodont. The species as identified by the author are as follows:—

Mastodonsaurus Jægeri, von Meyer.
——— *pachygnathus*, Owen.
Labyrinthodon leptognathus, Owen.
Diadetognathus (g. n.) *varvicensis*, sp. n.

In conclusion the author described some of the structural peculiarities of the teeth of various Labyrinthodonts.

III.—May 27th, 1874.—John Evans, Esq., F.R.S., President, in the Chair. The following communications were read:—

1. "On the last Stage of the Glacial Period in North Britain." By T. F. Jamieson, Esq., F.G.S.

In this paper the author arranged the Glacial phenomena of Scotland under the following three heads:—

1. The great early glaciation by land-ice (maximum effects of glaciation).
2. The period of glacial marine beds containing remains of Arctic Mollusca, when most of the country was covered by the sea.
3. The time of the late glaciers, the special subject of the paper.

After expressing himself in opposition to the hypothesis of a great polar ice-cap, the author described this last period as one not of mere local glaciers, but as characterized by a return of a great ice-sheet over nearly the whole of Scotland and Ireland; but he stated that this ice-sheet was probably neither so thick, so extensive, nor so enduring as that of the first period of glaciation, which cleared away every thing in the shape of superficial deposits down to the hard rock. He believed, however, that in the last period the mountains of Scotland and Wales, as well as the Pennine range and the rest of the north of England as far as Derby, were covered with thick ice, which in most parts reached down to the sea, and that extensive snow-beds prevailed over the rest of England. In the summer months the melting of these would give rise to streams of muddy water, and produce the superficial deposits of Brick-earth, Warp, and Loess; whilst, when the currents were stronger, perhaps from the thaw being unusually rapid, deposits of gravel would be formed. This second ice-sheet would gradually become less and break up into valley-glaciers, which in their retreat would leave kaims and eskers at low levels, and moraines in the mountain-glens. During this time no new great submergence of the country took place; and the last great modifications of the surface were subaërial, and not submarine, the work having been done by frost, rain, and glaciers.

DISCUSSION.—Mr. Jeffreys considered that the author's remarks relating to the beds containing arctic species of Mollusca were not quite correct. *Pecten islandicus* has been found in the drift of Scotland, but not in the seas at present surrounding that country. At depths of 30 or 40 fathoms many arctic shells in a semifossil state have been dredged, although they do not now live in those waters. *Mya truncata*, a species which lives in very shallow water, has been found in much deeper water in a semifossil state. At Fort William there is a bed containing arctic species of shells seven or eight feet above the level of the sea. Arctic shells of deep-water species have occurred 200 feet above the sea. Different conditions have existed at different parts of the same seas, altering the character of the Mollusca. The raising of the sea-beds above the level proper to enable certain Mollusca to flourish would cause them to become extinct.

Dr. Carpenter mentioned that cold water may be thrown up into very small depths under certain circumstances. Near Halifax, N.S., the surface-water is tolerably warm, but at no great depth the temperature falls to 35° F. In this case the rotation of the earth causes the cold water from the north to surge up on its western coast. The North Sea is a shallow sea, with a shoal in the middle, and having off the coast of Norway a deep channel, which conveys the cold arctic under-current, hence the east side is 10° F. colder than the west side. Local peculiarities of disturbance of temperature may thus occur within short distances.

Prof. Ramsay remarked that the author was not dealing with wide ocean-deposits, but with ice coming down to the sea from the land. He had described certain changes,—a great glacial period, a period of submergence, and a second minor glacial period.

Mr. Prestwich maintained that temperature was a most important question in connexion with the subject of Mr. Jamieson's paper. The glacial deposits were not formed in a deep sea, but in shallow water with shore temperatures. He thought that the paper was very speculative, and remarked that the evidence upon which the opinions expressed were founded was not always given.

2. "Notes on the Upper Engadine and the Italian Valleys of Monte Rosa, and their relation to the Glacier-erosion Theory of Lake-basins." By the Rev. T. G. Bonney, M.A., F.G.S.

The author stated that he had examined (1) the small lakes on the summit of the Bernina Pass. These were situated in a position very favourable to glacier-erosion, and he thought might be attributed to that cause. (2) The lakes on the upper part of the Maloya Pass, These lay in three rock-basins, and at first sight seemed favourable to the glacier-erosion theory; but further examination showed that they were in no way connected with the glacial system of the neighbourhood, and were probably preglacial. (3) The Val Bregaglia to the Lake of Como. The presence of barriers in the valley, its frequent V-like form, and the signs of glacial action to near the present level of the stream, seemed to indicate that the glacier had had but slight erosive power. (4) The Como arm of the lake. It was shown that the glacier, which was supposed to have excavated the lake, had passed over the ridge of Nagelfluhe and Molasse that incloses it, and had not been able to grind away its remarkably sharp crest. (5) Similar evidence was produced with regard to the Lake of Orta. (6) The Italian Valleys E. of Monte Rosa. These were shown to offer difficulties precisely similar to those of the Val Bregaglia. The author therefore argued that these cases showed how superficial the action of the glaciers had been; and that they must have been wholly inadequate to excavate the greater lake-basins, since no approach to this form, no U-like trough, was found in the valleys down which the glaciers had flowed on their way to the lakes. As then the principal features of the district appeared to be preglacial, he contended that disturbances of the beds of the valleys along lines transverse to their direction were more likely to have produced the lakes.

DISCUSSION.—Mr. Drew differed from the author, and thought that glaciers coming from different directions might have produced single results at certain points.

Prof. Ramsay was glad to find that the author was gradually coming round towards his own views, as he now admitted that glaciers may have excavated some lake-basins. He argued that the valleys originated before they were covered with a thick coating of ice, but he maintained that at its origin the ice would have great weight and excavating power.

Rev. J. F. Blake thought that if the slope of the bottom of the glacier changed, its excavating power would be increased.

Mr. Koch had sounded many lakes, and found great circular cavities, which he thought could hardly be due to ice-action. In winter glaciers move very slightly, and would be able to perform very little work.

The Author, in reply, remarked that ice-denudation is different from aqueous denudation. A glacier planes and could not cut out a notch. He said that he could only admit the smaller lakelets in special positions as the result of glacier-action. He did not think there was satisfactory evidence of the existence of an ice-sheet all over Switzerland. He urged that it is not always safe to argue from small phenomena to large ones.

OBITUARY.

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DR. F. STOLICZKA, F.G.S., etc.

Palæontologist to the Geological Survey of India.

THE sad news of the death of one of the ablest and most promising of palæontologists and naturalists has reached this country by telegraph since our last publication; and, although no particulars have yet been received, there seems no reason to doubt the accuracy of the statement that Dr. Stoliczka, while returning from Yarkand, with the other members of the embassy to which he was attached as naturalist, died, among the snowy passes of the Himalaya, on the 19th June last.

Ferdinand Stoliczka was born in Moravia in 1839 or 1840. Son of a distinguished forest-officer, he acquired, from his infancy and in his earliest rambles, that love of nature and familiarity with the habits and instincts of animals which distinguished his after-life. His early education was obtained at the "Gymnasium" of Kremsier (Moravia), and thence, at the termination of his school course, he proceeded to the University of Vienna. Under the able guidance of Prof. E. Suess, he was led to devote himself to geology, and with the friendly and almost fatherly aid of Dr. Hörnes, of the Imperial Cabinet, he made his first essay in palæontology. He took the degree of Ph.D. in the University. In 1861 he became attached to the Geological Survey of Austria, under the lamented Haidinger, and continued to work actively and earnestly for that institution until he left Europe. Several valuable papers mark his early and rapid progress at this time: "On some freshwater-beds in the Cretaceous formation;" "On the Gasteropoda of the Hierlatz beds;" "On the Oligocene Bryozoa of Lattdorf," and others. In 1862 the Director of the Geological Survey of India, then visiting Europe with a special view to obtaining assistants for the staff of the Survey, offered to Dr. Stoliczka, whom he met in Vienna, with Drs. Haidinger and Suess, an appointment, which he accepted, and at the close of that year he sailed for Calcutta. Arriving in the East, he at once commenced his labours, and from that time until last year he had devoted himself with untiring zeal to the study of Indian fossils. During those few years more than 1600 pages of descriptive matter, and more than 200 large plates (quarto) of fossils, have been issued under his care. The entire series of the Cretaceous fossils from S. India, one of the most valuable and complete series ever yet published from a single limited group, has been illustrated in four very large volumes, and descriptions of Crabs from Kutch, of Frogs from Bombay, and fossils from the several geological formations of the Himalaya, have also been issued. The best proof of the value set upon Stoliczka's labours is given in the fact that the Government of India had just sanctioned double the amount of grant for these publications, so as to facilitate and expedite their issue. Nor was his work confined to the examination of fossils in the cabinet. In June, 1864, as soon as it was practicable for him, started to the Himalaya, and succeeded in making a very wide *across the* highest passes into Thibet and back. The results of this trip were given in a remarkable memoir in the Geological Survey of India (vol. v.), with sections, fossils, etc. In the following year he started again for the hills, and after one of the most extended and fatiguing journeys ever accomplished in one season, and crossing almost all the principal passes, and many "minor passes about 18,000 feet in elevation," the trip extending over more than six months, he returned to Calcutta. The wonderful energy and zeal of Stoliczka enabled him to go through this, but, as he feelingly says himself, "after a horrible experience of hill travelling." Still the exertion and exposure was too great for him, and he was for many months after extremely unwell, and though never interrupting his work, only able to go on with difficulty and suffering. In the spring of 1867, the only chance of his permanent recovery appearing to be a visit to Europe, and cessation of work for a time, Dr. Oldham took him with him for a six months' tour, During this time they visited most of the principal collections of geology in Europe, and he thus made the acquaintance of many till then unknown to him. Everywhere he studied these European collections with vivid interest. During this trip with Dr. Oldham, the extensive series of fossils collected by Prof. Klipstein, Giessen, was secured for the Calcutta Museum.

Returning about the end of the year to Calcutta, he resumed his work, with greatly improved health, though still far from strong. But each season appeared to add to his vigour, and he continued to improve in strength. During the succeeding years he made several minor trips to Burmah, Penang, Singapore, the Andaman and Nicobar Islands, to Darjeling, etc., invariably bringing back valuable contributions to the natural history of the places visited. In 1871 he spent the cold season and part of 1872 in Kutch, which he carefully examined palæontologically under many difficulties. He was able to establish several very important sub-divisions in the rocks there, and to fix their relations to European groups; and he brought back a very extensive collection of fossils. This series was in actual preparation for publication when he left Calcutta, and already a commencement had been made with the Cephalopoda by Dr. Waagen, his colleague. In the early part of 1873 he made a trip to the Andaman Islands, the Nicobars, etc., when he was very nearly lost, his eagerness of research leading him too far into the forest, from which he was only recovered after a long search by his companions in the trip. When he started on this trip, his longing hope was to visit his old colleagues in Vienna during the Exhibition in 1873, and all arrangements had been made for this. But on his return, finding that it was intended to despatch an envoy to Kashgar, to return the visit of the Yarkand envoy to the Viceroy in India, his love of travel and research was all rekindled, and he tried eagerly to seize such an opportunity of seeing countries rarely visited by Europeans, and regarding which so little was known. He at once abandoned all prospects of coming to Europe, and prepared for the journey. After considerable delay the party started, rather later in the year than is desirable, to cross the snowy passes. Dr. Stoliczka suffered very severely in this inclement and severe exposure, and it was even reported that his strength had succumbed to the trial. But letters from him up to a period just before his starting to return led to the hope that he had quite recovered from this attack. But it was not permitted to him to reach his friends again, and he died as stated, amid some of the wildest scenery of the hills he loved so dearly, on the 19th June.

Few men have been more thoroughly saturated with the love of their pursuits and of nature than was Stoliczka. It was this which rendered his influence, always for good, much more widely felt than merely in his own department. There, too, his unremitting devotion and earnest labours were the strongest stimulant to others to do their best, in order to keep pace with him; but this influence had also made itself felt by every cultivator of natural science in India. For several years Stoliczka was Natural History Secretary to the Asiatic Society of Bengal, and it is mainly to his exertions that this Society owes its resumption of much of its early vigour. Its journal for years past is full of contributions of high value from his pen in almost every branch of natural history. How highly his services were appreciated and valued by his colleagues will be best seen in the reports of the Geological Survey and of the Asiatic Society, while his happy disposition and the genial sociality of his temperament, coupled with the inflexible rectitude of his character, rendered him a general favourite. Cut off at the early age of 35, few men will be more deeply regretted by those who had the privilege of knowing him, few will be more truly missed than Ferdinand Stoliczka.

CORRESPONDENCE.

RAISED BEACHES AND ANCIENT IRISH VOLCANOS.

SIR,—The GEOLOGICAL MAGAZINE for May, 1874, has just come to hand. With reference to Mr. Hardman's paper, p. 215, paragraph second, he will find another case of raised beach and submarine peat, also on the south coast of Ireland, mentioned in Quart. Journ. Geol. Soc. Lond. vol. xxiv. p. 4; also in GEOL. MAG. 1867, Vol. IV. p. 8; May, 1868, p. 244; October, 1868, p. 484.

It would be interesting if any concordance could be found between the phenomena of the two places, though I cannot recall any evidence of three submergences at the one I refer to near Youghal.

In Professor Hull's address, in the same Number, p. 205, I presume he did not intend to notice all the volcanic eruptions of Carboniferous times in Ireland or he would not have omitted to mention Croghan Hill, near Phillipstown, thought by the late Professor Jukes to be the funnel of an old volcano. A. B. WYNNE.

MURREE, PANJAB, *June 10th*, 1874.

MR. JOSEPH PRESTWICH, F.R.S., F.G.S., has been appointed to the office of Professor of Geology in the University of Oxford, as successor to the late Prof. Phillips.

The Council of the Institution of Civil Engineers have awarded a Telford Medal and a Telford Premium to Prof. Prestwich, F.R.S., Assoc. Inst. C.E., for his paper, "On the Geological Conditions affecting the Construction of a Tunnel between England and France."

THE

OLOGICAL MAGAZINE.

NEW SERIES. DECADE II. VOL. I.

No. IX.—SEPTEMBER, 1874.

ORIGINAL ARTICLES.

EMARKS UPON THE RELATIONS AND GROUPING OF THE PERMIAN AND TRIASSIC ROCKS.

By HORACE B. WOODWARD, F.G.S.,
Of the Geological Survey of England and Wales.

; physical history of the Permian and Triassic rocks of Great
Britain has been told by Professor Ramsay, who has pointed
at the beds were deposited in great inland lakes, for the most
alt.[1] Without entering into the consideration of this subject,
seems to be much that requires to be unravelled in regard to
ructure of the beds individually, and much that has yet to be
ned in regard to the relations and grouping of the rocks.

their general lithological characters there is a marked simi-
throughout the Permian and Triassic series, consisting as they
red sandstones, conglomerates, and marls, with occasional beds
estone. Originally, the whole of these rocks were classed as
Red Sandstone, and the name "Poikilitic," subsequently sug-
by Conybeare, as an equivalent term, is one that possesses
advantages to recommend it. The ideas that as students we
from our text-books are that the Permian beds form a group
in unconformably by the Trias, and sufficiently distinct
ir palæontological aspect to be classed as Palæozoic; whilst
iassic beds (classed as Mesozoic) are divided into Bunter and
r, and are regarded as equivalents of the same beds on the
ent—the Muschelkalk being considered to be absent in the
a area, and the Keuper beds to rest unconformably upon the
r.

exact evidence upon which these ideas are based appears,
er, to be conflicting when it comes to be examined into, and
ntly to have but a very local significance, as more recent re-
es have tended to show. It may therefore be interesting to
attention to some of the points of the case, and to notice
of the later opinions expressed.

history of the researches into the Permian and Triassic beds
en given at length by Professor Hull in a work detailing the
igations of the Geological Survey in the midland counties of
nd: it will suffice therefore to refer to his Memoir[2] in regard
part of the subject.

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[1] Quart. Journ Geol. Soc., vol. xxvii. pp. 189, 241.

[2] Published by the Geological Survey.

In our tables of British[1] strata we generally find a classification similar to the following:—

Trias	Keuper	Red and Variegated Marl.
		Lower Sandstone and Marl.
		Dolomitic Conglomerate.
		(Muschelkalk wanting in England.)
	Bunter	Upper Mottled Sandstone.
		Pebble-beds.
		Lower Mottled Sandstone.
Permian	Upper or Magnesian Limestone Series.	Upper Red Marl and Sandstone.
		Upper Magnesian Limestone.
		Lower Red Marl and Sandstone.
		Lower Magnesian Limestone.
	Lower, or Rothliegende	Red Marl, Sandstone, Breccia and Conglomerate.

For this series the term "Poikilitic" has been employed by Prof. Phillips; and in his recent work on the "Geology of Oxford and the Valley of the Thames," he has treated all the beds "between the Coal and the Rhætic base of the Lias as one great physical 'Poikilitic' series." He observes (p. 88) that "in some respects and in some districts it is, however, more convenient to adhere to the old established alliance of the Permian many-coloured deposits, with the variegated sandstones and clays of the New Red series; for the *physical history* of these two great groups is, on the whole, one great sequence of natural operations. There are indeed cases, as in Lancashire and Cheshire, and in a less degree in Derbyshire, where a kind of gradation appears between the Coal formation and the Permian sandstones, which are locally conformed to it; so that, in fact, we shall do wisely to adapt our classification to the region which specially engages attention, for local description and limited inference."

In East Yorkshire there is considerable similarity between the beds at the base of the Permian series and those at the top of the Coal Measures, and the beds have been differently classified in places by geologists.[2]

Prof. Hull, however, believes that there is an unconformity between the Permian and Carboniferous rocks in Lancashire and Yorkshire.[3]

It is considered by some that the different members of the Permian formation are not strictly conformable to one another. A most decided instance of unconformity is stated to be in the railway-cutting at Tadcaster. "The Middle Marl has there thinned away to a mere seam, so that the Upper Limestone rests almost directly on the Lower, and at the base of the former there is a thin bed of gravel formed of Lower Limestone pebbles."[4]

In isolated masses, as might be expected, it is not always easy to distinguish between the Permian and Triassic beds. Thus certain red sandstones in Lancashire, referred to the Permian period by Mr. Binney, have been considered as Bunter by Prof. Hull; although the latter admits that, "isolated as the beds are here, there can be no certainty regarding their age."[1]

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[1] See Mr. Bristow's "Tables of Strata" (published by Stanford.).

[2] See Explanation of Quarter Sheet 98 S.E. of the Geological Survey Map of England, pp. 28, 29.

[3] Quart. Journ. Geol. Soc., vol. xxiv. p. 327.

[4] Explanation of Quarter Sheet 93 S.W., p. 10.

The Rev. A. Irving, in an interesting paper upon the Geology of the Nottingham District, remarks that there are clear signs of continuous deposition of the Permian and Lower Bunter rocks; and, so far as the area is concerned, the stratigraphical data seem to point to the Permian and Bunter as but portions of one great unbroken sequence of rocks. Referring to Prof. Hull's Memoir on the Permian and Triassic Rocks of the Midland Counties, he comments upon the meagre evidence on which the great line of demarcation between the Bunter and Permian rocks has been drawn in the northern Permian area.[2]

Turning to the Triassic beds, Mr. Irving refers to the eroded or denuded surface of the Bunter, where overlain by the Keuper, which has been observed in the neighbourhood of Nottingham.

In County Down, according to Mr. J. Anderson, however, the Keuper and Bunter divisions appear conformable.[3]

In regard to the principal cases of unconformity that have been noticed as occurring between the Keuper and Bunter strata, reference may be made to Prof. Hull. He remarks that "there is every reason to believe that the bed of the New Red Sandstone sea over the English area was elevated into dry land during the succeeding period of the Muschelkalk. This elevation, and subsequent submersion at the commencement of the Keuper stage, has left its evidences in the eroded surface, and slight unconformity, which is *locally*[4] observable between the two divisions of the Trias of England."[5] Mr. Hull frequently alludes to the highly eroded surface of the Bunter where overlain by the Keuper; in regard to the unconformity in dip, however, the following remarks of his are important:—"The district around Ormskirk affords several very interesting sections in the Trias, and it is the only one with which I am acquainted where we obtain in one section visible evidence of the unconformity of the Bunter and Keuper divisions. The deep sections opened out by the Ormskirk and St. Helen's Railway, if not everything that could be wished for the purpose of demonstrating the discordance between the two divisions of the Trias, are probably as satisfactory as the nature of the rocks admit of. . . . The basement bed of the Keuper Sandstone consists of coarse light red or brown grit, containing small pebbles of white quartz, and traversed by planes of current-bedding. It rests on a distinctly eroded surface of the Upper Mottled Sandstone of the Bunter series. . . . . Upon a careful examination the Keuper Sandstone will be found to overlap successive beds of the Bunter, which are distinguishable principally by colour, but also by other mineral characters." Further on Mr. Hull speaks of it, as "this, to all appearance, unconformable overlap of the lower division of the Trias."[1]

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[1] Memoir on the Triassic and Permian Rocks, p. 41.

[2] GEOL. MAG. Decade II. Vol. I. pp. 315, 316.

[3] Proc. Belfast Nat. Hist. Soc., 1873, p. 41.

[4] The italics are mine.

[5] The Triassic and Permian Rocks of the Midland Counties of England. Memoirs of the Geological Survey of England and Wales, 1869, p. 66.

In Shropshire, Mr. Hull remarks that "there is some uncertainty as to the exact line of demarcation between the Bunter and Keuper series, as the uppermost beds of the former are sometimes sufficiently hard for building purposes."[2]

It is unnecessary to enter further into a discussion of the relations of the Bunter and Keuper formations, for these quotations will be sufficient to indicate the unsatisfactory evidence of any considerable break having occurred between the subdivisions of the Triassic rocks in England, to warrant the notion that "the close of the Bunter Sandstone period in England was accompanied by a general elevation of the whole of the Triassic area, in which condition it remained throughout the period of the Muschelkalk."[3]

In the south-west of England, or in the country that lies between Bristol and Exmouth, there is a considerable development of the New Red rocks, and these have been generally included in the Trias.[4] In the smaller maps two divisions have been made, namely,

1. New Red Marl and Dolomitic Conglomerate.
2. New Red Sandstone and Conglomerate, as in Greenough's Geological Map of England and Wales. Or
1. New Red or Keuper Marl and Sandstone.
2. New Red or Bunter Sandstone, as in Ramsay's Geological Map of England and Wales.

In the published Geological Survey Maps, two divisions are likewise made, in South Devon, of New Red Marl and Sandstone;[5] the latter including the pebble-beds of Budleigh Salterton and the breccias of Teignmouth. The Dolomitic Conglomerates of Mendip and those of West Somerset were, however, in places coloured distinctly.

Such being the case, there must consequently be some confusion in regard to the classification of these Triassic rocks, and more particularly when no recognized unconformity has been observed to justify the distinctive terms of Bunter and Keuper.

Turning our attention to the coast-sections between Seaton and Exmouth,[6] we find a very clearly developed series. A little east of Seaton, we meet with the lower Rhætic marls, and thence trace their passage downwards into the variegated marls which appear along the cliff, at the base of the Greensand and Chalk. West of Seaton, they form low cliffs of marl, which appear again at Branscombe, dipping gently to the east. Continuing towards Sidmouth, the beds become less calcareous and finally quite loamy, until lower down in the series sandstone crops out at Sidmouth, forming a gentle anticlinal at the town, and being overlain again by loamy beds to the west. Here the sandstone contains seams of red and mottled clay. Continuing westwards the sandstone, containing seams of calcareous conglomerate, forms the low cliff at the mouth of the Otter. The sandstone continues through Budleigh Salterton; and in the high cliff to the west, beneath it, comes the famous pebble-bed, and this again overlies variegated marl, with hard nodules in the lower part, where the beds are less calcareous, although variegated and with marly structure: these beds are interspersed with bands of sandstone, and towards Exmouth there is an alternation of marl and sandstone. In this direction the beds are much disturbed by small faults, which let down the marl at Exmouth: they are found to rest upon breccia.

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[1] *Op. cit.* pp. 86, 87. [2] *Idem.* p. 64. [3] Hull, *op. cit.* p. 106.

[4] The name Permian has sometimes crept in through a misunderstanding of the Dolomitic (or Magnesian) Conglomerate.

[5] These Maps include Sheets 19, 20, 21, and 22. The Sandstone is not designated as Bunter, and the boundary between it and the New Red Marl is not engraved in Sheets 21 and 22. The whole area has been undergoing revision, and the new edition of Sheet 19 is now published.

[6] This coast-line has been described and diagrams of the sections drawn by De la Beche, Trans. Geol. Soc. 2nd series, vol. i. p. 40, plate viii. (Bridport to Sidmouth); Buckland, *Idem.* p. 95, Plate xiv. (Portland to Lyme Regis, and Branscombe to Sidmouth); Whitaker, Quart. Journ. Geol. Soc. vol. xxv. p. 152 (Dowlands Landslip to Babbacombe Bay). See also Pengelly, Trans. Plymouth Inst. for 1862-65; Trans. Devon. Assoc. for 1863. My notes on the coast-section (which, however, add nothing to what has been written before) were made in company with my colleague, Mr. W. A. E. Ussher. He has done the greater part of the re-survey

Crossing over the mouth of the Ex, we come to Langstone Point, and here we find rocks the relation of which to the marls and sandstones of Exmouth is clear, and the dip, which continues on the whole uniform, would place them lower in the series: they form a continuation of the breccia, which just appears at Exmouth.

The Cliffs between Langstone Point and Dawlish show sandstone and breccia interstratified, sometimes the one predominates, sometimes the other. They are much faulted on a small scale.[1] Between Dawlish and Teignmouth the dip continues uniform, and the cliffs display a series of breccias with sandstone interstratified. Between Teignmouth and Babbacombe the beds undulate; the lowest bed, which might be termed a conglomerate, is conspicuous from the fragments of limestone contained in it.[2]

At Livermead and Roundham Head, the beds appear similar to those on the Dawlish coast, and the sections show (1) breccia, (2) sandstone, and (3) breccia, with the conglomerate at base.

There is thus a continuous series of rocks from the breccias and sandstones of Dawlish and Teignmouth up in to the Rhætic beds of Axmouth. The whole of these beds might be termed Keuper; but owing to their great thickness, there is some justification in thinking that the Muschelkalk might be represented, as well as the Bunter, and by sediments of a different lithological character.[3] It seems

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of the red rocks between Taunton and Exeter, in which tract he has been enabled to trace out, with marked persistence, the different divisions seen in the coast-section, whilst I have been similarly successful in the smaller areas on which I have been engaged. The details of this work will probably be published on some future occasion.

[1] See section by Godwin-Austen, Trans. Geol. Soc. 2nd ser. vol. viii. pl. xlii. fig. 5.

[2] Here, it may be observed, we approach the Torquay limestone.

[3] See the writings of De la Beche, and Pengelly; also Whitaker, *op. cit.* p. 157; and H. B. W. Science Gossip, No. 115, July, 1874, p. 165. The thickness of the strata has been estimated at from 1850 feet to four miles or more. Probably the *former estimate by De la Beche is* nearest the truth.

best therefore to term the whole development the Triassic series, without making any subdivisions (which would have no real value) to correlate them with the divisions made on the Continent.

The consideration of the red rocks in the south-west of England, with their many evidences of false-bedding and irregular accumulation, has led me to be rather sceptical of the importance attached to the unconformities observed to the north; but my knowledge of that district being confined to the inspection of some isolated sections in Cheshire and Nottinghamshire, I have naturally no opinion to offer concerning them.

Whilst the organic remains of the Permian period approach nearer to those of the Carboniferous rocks than to the Trias,[1] it seems important to keep in mind their approximation in physical character to the newer rocks; and when we take into consideration the evidences of unconformity that have been recognized in the Permian rocks themselves, to consider whether they are not equally important with those found locally to exist between the Permian and Bunter beds, and those between the Bunter and Keuper.

The absence of the Muschelkalk in the British area must not of itself be taken as any evidence whatever of an unconformity, considering the different conditions under which the beds were deposited in each area.

Thus it will be seen that there is no very strong evidence for a great break in the Triassic series throughout the British area, but that locally in them, as in the Permian series, there were pauses in deposition accompanied by some erosion of the beds.

The results of further researches may be looked for with interest, and more particularly in regard to the Permian beds.

Lyell has remarked "that nowhere have geologists found more difficulty in drawing a line of separation than between the Secondary and Primary series,"[2] and perhaps future researches may lead to the resumption of the term "Poikilitic" as a general term to embrace the Permian and Trias, especially as it has been used by such men as De la Beche and John Phillips.

II.—Notes on the Pleistocene Deposits yielding Mammalian Remains in the Vicinity of Ilford, Essex.

By Henry Woodward, F.R.S., and William Davies,
Of the British Museum.

THE Valley of the Thames, with its numerous tributaries, like nearly all our English river-courses, contains more or less extensive deposits of Brick-earth and gravel, which were accumulated at a period long antecedent to that when the streams had cut their higher channels down to the depth at which they at present flow.

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[1] The Permian flora is, upon the whole, very nearly allied to that of the Coal-measures, though the Permian species are mostly distinct, and there are some new [redacted]era. In the Trias are found some Palæozoic types, as *Calamites.*—Nicholson, ual of Palæontology, pp. 494, 533.

dent's *Elements*, 1871, p. 366.

In some places, as pointed out by Mr. Prestwich,[1] fragments of these ancient fluviatile deposits have been preserved as older river-valley terraces; in other spots, as in the neighbourhood of Ilford, they still form wide sheets, covering a considerable low-lying tract, which probably has been elevated and depressed more than once since its original deposition.

The bottoms of the valleys are for the most part occupied by more modern prehistoric deposits seldom raised much above the level of the stream. (See Geol. Mag. 1869, Vol. VI. p. 385.)

But even where their actual relative elevation is an uncertain guide, there is always a marked difference between the older and newer deposits as regards the materials of which they are composed.

The prehistoric as well as the present alluvia are mostly composed of clays, more or less stiff, and the gravels of pebbles more or less evenly sorted, both having been formed under conditions of climate not very different from those at present existing.

The Pleistocene Brick-earths, on the other hand, very seldom consist of stiff clays, and the gravels contain large and small pebbles and angular blocks confusedly mixed together, clearly indicating that the transporting power of the rivers at that period was greater in certain seasons than at the present day, and that freshets were probably of more frequent occurrence.

But perhaps the most striking difference which they present is offered by the remains of the fauna associated with each: for whereas the prehistoric and modern deposits of our river-valleys are characterized by stone-implements and other relics of human industry, associated with remains of animals at present indigenous to our island, or which are known to owe their extermination to man's agency, the Pleistocene Brick-earths and gravels of the Thames reveal no trace of man's presence,[2] but present us with a fauna almost wholly dissimilar from that now living in Europe, and most if not all of the species of which are extinct.

The brick-pits of the neighbourhood of Ilford have long been celebrated for the wonderful variety of extinct Mammalian remains which they yield. So long ago as May, 1824, Mr. Gibson, of Stratford, obtained from the brick-field on the London turnpike-road a large portion of the skeleton of an elephant, Mr. Clift and Prof. Buckland being present at the exhumation of the bones. Prof. Morris refers to Mr. Gibson's Collection in an article on "Deposits in the Valley of the Thames containing Mammalian Remains" (see Magazine of Nat. Hist., 1838, vol. ii. new series, p. 540). He mentions the "remains of the horse, elephant (a tusk 12ft. 6in. long), rhinoceros, deer, and two species of oxen; the bones are found in every stage of growth, rarely broken or rolled, and (land and freshwater) shells occur in abundance." Prof. Morris cites as from Ilford, *Cyrena trigonula (fluminalis), Pisidium amnicum, Unio pictorum, Succinea oblonga, Helix hortensis, H. hispida, Limnæa auricularia, L. peregra, Planorbis corneus, Paludina impura* (*op. cit.* p. 544). We have not been able to discover where the specimens once forming Mr. Gibson's collection are now preserved.

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[1] Phil. Trans., vol. cliv.

[2] It is true that the Rev. O. Fisher communicated to the Geol. Mag. that he had found an undoubted implement in the gravel at the base of the Crayford Brick-earth; see Geol. Mag. Vol. IX. p. 268; see also Mr. Boyd Dawkins, in Quart. Journ. Geol. Soc. Lond., vol. xxviii. p. 414. These may, however, and probably did belong to a later date, the deposits in which they occur having been subsequently, in part perhaps *locally, disturbed* and re-assorted.

The pit to which Sir Antonio Brady's attention has been mainly directed, and from which nearly all his magnificent series of Mammalian remains have been obtained (and which now form part of the National Collection in the British Museum), is known as the Uphall Brick-field, and is situated on the right-hand side of the lane leading to Barking. The ground forms a low terrace, bordering the small River Roding on the one side, and on the other it slopes gradually down to the Thames. The height of the surface of the ground at the pit is about 28 feet above the Thames H. W. M. (Prestwich, Geol. Mag. 1864, Vol. I. p. 245).

Probably no independent geological investigator, since the early days of Buckland, Trimmer, Prestwich, and Morris, has paid such careful attention to the structure of the Thames Valley, and of its contained deposits, as Mr. Searles V. Wood, jun., F.G.S. Numerous papers on this subject have been communicated by him to the Quarterly Journal of the Geological Society, and to the Geological Magazine. Writing thereon in 1866 (Geol. Mag. Vol. III. p. 59), Mr. Wood observes: "The Brick-earth of Ilford, both that of Uphall and that of the London-road Field, is a deposit *underlying* the Thames gravel and unconformable to it." He also speaks of it as *anterior* in date to the similar deposit of Grays, which likewise contained *Cyrena fluminalis*, and other purely freshwater shells.

In a letter to one of the authors (dated March 1st, 1874), Mr. Wood writes:—"When I wrote the paper in Vol. III. (1866), I was under the impression that though the Grays Brick-earth was clearly newer than the main sheet of the Thames gravel (it forming distinctly a terrace beneath it), the *Cyrena* Brick-earth of Ilford, and of Crayford and Erith was anterior to, and passed underneath it. Some year or two afterwards, however, I satisfied myself that this was an error as concerned Crayford and Erith, and I wrote a letter to the Geological Magazine (Oct. 10, 1868, Vol. V. p. 534), directly to acknowledge this.

"The Ilford bed lying flush with the gravel sheet of that part of Essex does not present the means of determination by section, but I cannot doubt, however, that it is identical in age with the *Cyrena* beds of Grays, Erith, and Crayford.

"Such being the case, so much of the section No. 3, given at p. 61 of the Geological Magazine, 1866, Vol. III., as shows this Brick-earth (x 4′) as underlying the gravel (x 4″), is incorrect. . . . .

"The subject, however, is obscure, and while the Brick-earth at Ilford, Grays, and Erith lies low, and forms a lower terrace to the main sheet of the Thames gravel, it rises at Crayford to a greater elevation, nearly 80 or 90 feet in parts, and forms a high terrace above the gravel of the Cray and Darent Valleys, but below the main gravel sheet which forms Dartford Heath (see bed *b* of Sect. 3).

"This anomaly and seeming contradiction is due in my view to the reversal of the drainage during the progress of the formation of the Thames Valley, and the denudation of the Weald as discussed by me in my paper in the Quart. Journ. Geol. Soc. 1871 (vol. xxvii. p. 3)."

In order to make the foregoing view more intelligible Mr. Wood has most obligingly prepared a fresh Section (Sect. No. 3), and adds:

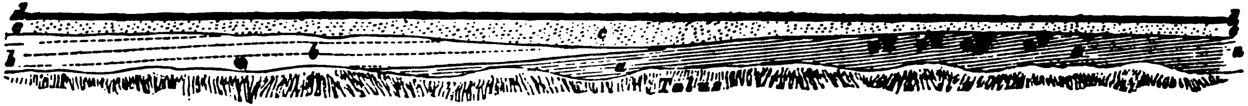
"Crayford is nearer to the region of Wealden elevation than the other localities of the *Cyrena* Brick-earth; and this Brick-earth has there been so elevated that the gravel of the Cray and Darent Valleys (*c* of Sect. 3) forms in places a very distinct deposit occupying the valley bottoms, and lying at a level considerably below that of the *Cyrena* Brick-earth. This gravel *c* is, in my view, a deposit formed since the drainage was reversed into its present direction; the *Cyrena* Brick-earth, on the other hand, having been deposited while the drainage from the Thames Valley flowed into the sea which covered the Weald. (See Section 3, p. 396.)

"I should, however, point out, as one of the perplexing features of this obscure subject, that if we follow the gravel *c* from the Cray and Darent Valleys to the edge of the Stone marshes, and crossing the Thames pursue it from its re-appearance above the West Thurrock Marshes to the edge of the *Cyrena* Brick-earth at Grays, it seems to inosculate with the gravel which (as shown in the section at page 62 of the Third Volume of the GEOLOGICAL MAGAZINE) partially underlies the Brick-earth at that place. I, however, believe that this inosculation is not real, but that the gravel, *c*, really lies up against the beds of gravel, sand, and Brick-earth which form the *Cyrena* deposit of that place, and which are shown in the present Section (No. 3) under the letter *b*. All the gravel and Brick-earth beds occurring in the valleys of the Thames, and of its tributaries, are now pretty generally admitted by geologists to be posterior to the true Glacial period; and their relation to the extensive deposit of Glacial Clay which covers so much of the Midland and Eastern Counties (bed No. 6) is shown by Section No. 1" (reprinted from page 43 of the Fifth Volume of this Magazine).

To return to the Ilford Brick-fields, the *Cyrena* Brick-earth here attains a thickness of nearly twenty feet. It may be seen in the field on the London-road resting in one part direct on the London-clay, while in another part it has a thin band of shingly gravel beneath it. In the Uphall Brick-field its position relatively to the newest gravel is best shown, the two deposits being unconformable (see Section 2, reproduced here by permission of Mr. S. V. Wood, jun., from Vol. III).

When we consider the limited area from which the collection has been made, it seems not a little remarkable that it should so well represent the vertebrate fauna characteristic of these deposits, in regard *to the number of* species; whilst it greatly exceeds in number

Section 2.—SECTION EXHIBITED BY THE UPHALL BRICK-FIELD, ILFORD (Reprinted from Vol. III. of the GEOLOGICAL MAGAZINE).

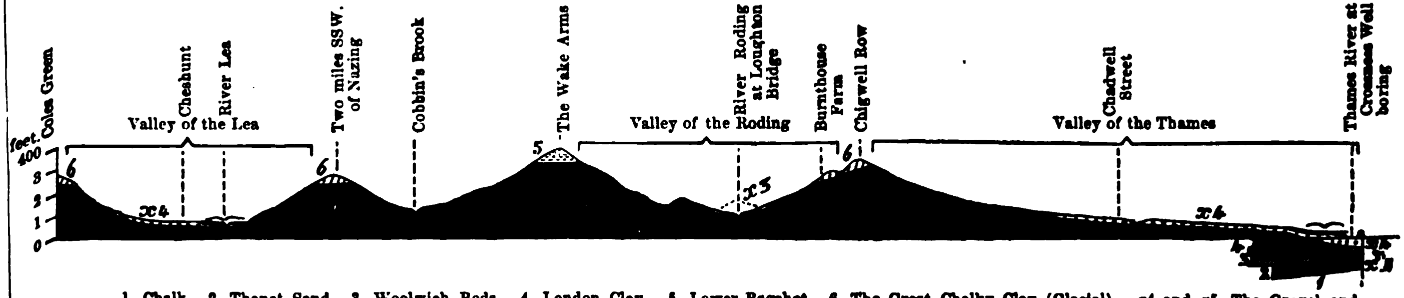


b. of Sect. 3 {
a. Clayey Brick-earth, with *Cyrena fluminalis* and other freshwater mollusca.
b. Bright yellow sand, with *Cyrena fluminalis*, and in which, at the point marked by the asterisk on the left hand, occurred the elephant remains described at p. 242 of Vol. I. of the GEOL. MAG. The black pot holes, marked by asterisks on the right of the section, are due to the denudation of *a*. and *b*. prior to their unconformable overspread by *c*.
}

c. Newer gravel, probably identical with that shown under the same letter in Sect. 3.
d. Humus, etc.

Section 1.—GENERAL SECTION TO SHOW THE POSITION OF THE THAMES VALLEY BEDS RELATIVELY TO THE GLACIAL BEDS OF THE MIDDLESEX AND ESSEX HEIGHTS.

(Most obligingly drawn and communicated by Searles V. Wood, jun., Esq , F.G.S.)



1. Chalk. 2. Thanet Sand. 3. Woolwich Beds. 4. London Clay. 5. Lower Bagshot. 6. The Great Chalky Clay (Glacial). *x*4 and *x*5. The Gravel and Brick-earth of the Thames and Lea Valleys, with which are associated the beds *a*. *b*. and *c*. of Section 2 and *a*. *b*. and *c*. of Section 3. *x*3. Gravels of the Roding Valley. ⌣ Alluvium.

ecimens any hitherto made from this neighbourhood. The ve proportions of the remains of the several families are, also, as are generally found in similar deposits in other localities.

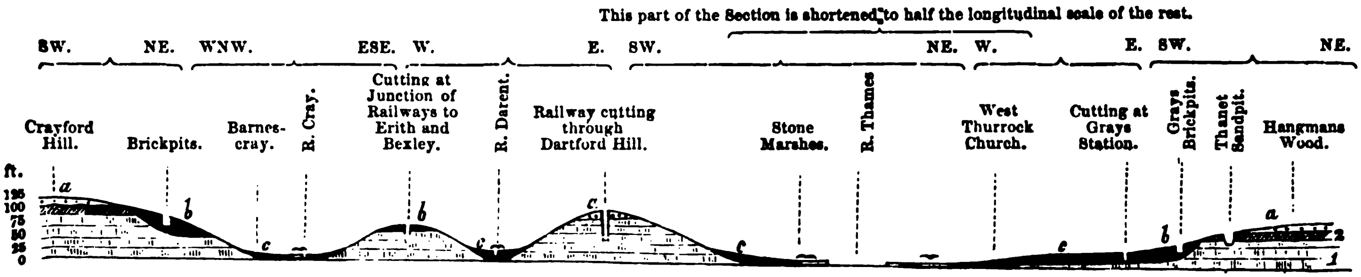
the Carnivores the remains are few—only eleven—and belong e Lion, Fox? (one fragment), and the Bear. The first is re- nted by two examples; but, as we might expect, from the n active habits of the Felidæ, their remains are comparatively in all aqueous deposits, being more generally found in caves rock fissures. Of the Bear two species are recorded as having found at Ilford, viz. *Ursus arctos* and *U. ferox;* but as neither nor teeth are in the collection, no satisfactory determination as ich of these species each bone should be respectively referred, l well be made, and has not been attempted.

e remains of the Proboscidæ are numerous, and are referable o species, *Elephas primigenius* and *E. antiquus.* This group t only numerous in specimens (about 300), but also in indi- ls, of which there are the remains of 84, as indicated by jaws teeth alone, exclusive of the tusks; of these there are 14 ples, large and small. Even assuming that many of the limb ther bones might have belonged to one or the other of these iduals, we may still fairly estimate that there are portions of than 100 Elephants in the collection; for there are few in- es in which more than one bone could be assigned to the same l. Of the greater portion of the bones of the skeleton there any fine examples, and they illustrate, together with the teeth aws, individuals of every age and size, from the smallest suck- alf to the animal of most mature age.

e Pachyderms are represented by three genera, viz. *Rhinoceros,* , and *Hippopotamus;* and collectively they comprise 121 speci- . Of the *Rhinoceros,* remains of three species are present, *R. hinus, R. megarhinus,* and *R. tichorhinus;* those of the first being ost numerous. Of this species there are 77 separate remains, sting of skulls, jaws, detached teeth, vertebræ, and limb-bones. Megarhine Rhinoceros, of which there are seven examples, is aratively rare at Ilford; whilst at Grays, a few miles off, it is ecies most frequently found. The Tichorhine Rhinoceros is also n this locality, being only represented in the collection by two ents. Of the remains of the Horse there are 34 specimens, ling a fine fragment of the skull. The Hippopotamus is only sented by a single fragment—the body of a lumbar vertebra.

e Ruminant remains constitute fully one-half of the collection, ering more than 500 specimens, consisting of teeth, skulls, limb, and other bones, with antlers and horn-cores, belonging genera *Cervus, Bison,* and *Bos.* Of the first there are 7 speci- of the great Irish-deer, and 50 of the Red-deer, besides 13 ents of undetermined species; making an aggregate of 70 s. The Bison, judging from the paucity of its remains in the tion—only 34—was a rare animal, when compared with those congener, the large Bos, which exceed 300.

is *evidence of numbers* is important as tending to prove that



KEY TO MAP ON OPPOSITE PAGE.

□ ALLUVIUM.

▨ BRICK-EARTH.

░ GRAVEL.

■ LONDON-CLAY.

■ WOOLWICH AND THANET BEDS.

▥ CHALK.

— ROADS.

━ RAILWAYS.

SECTION 3.—Length: Nine Miles along an Irregular Line.

(For this section we are indebted to the kindness of Searles V. Wood, jun., Esq., F.G.S.)

1. The Chalk. 2. The Thanet Sand.

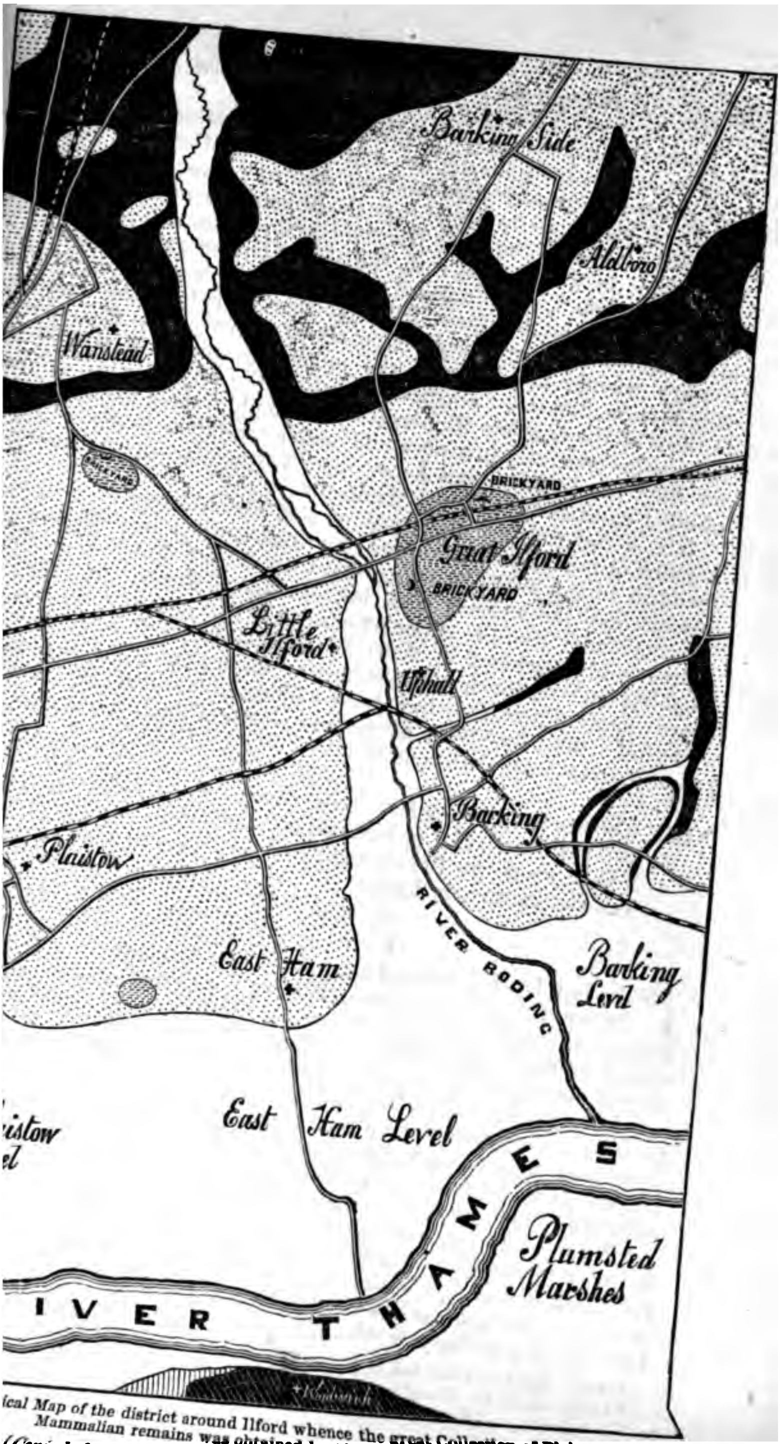
a. Thames Gravel of the Highest Elevation and which covers Dartford Heath } Formed when the Sea occupied the Weald, and the Drainage from the Thames area passed into it.

b. Cyrena Brick-earth } Formed when the Sea occupied the Weald, and the Drainage from the Thames area passed into it.

c. Gravel (with some Brick-earth) formed since the Drainage acquired its present direction.

~ Recent Alluvium.

N.B.—The Cyrena Brick-earth at both Grays and Crayford is partially underlain by Gravel.



ical Map of the district around Ilford whence the great Collection of Pleistocene Mammalian remains was obtained by Sir Antonio Brady, F.G.S.
(Copied by permission from the Geological Survey Map.)

the heavy Bovidæ were either subjected to greater casualties, by floods or other causes, than the lighter and more fleet Cervidæ; or that they existed in greater numbers and roamed in very much larger herds. It also tends to prove that the Ruminants numerically surpassed the whole of the other Herbivores, the Mammoth alone being comparable in this respect with the Oxen, but surpassing them in size and weight; and compared with which the bones of the Horse and Rhinoceros are but few. This evidence leads to the assumption also that the Rhinoceros was not a common animal in the Pleistocene country whence the bones of the numerous animals deposited at Ilford were derived. For assuming that the habits were similar to those of the existing Rhinoceros, we should expect to meet with its remains generally in places and under conditions better adapted for their preservation, and hence more frequently found than that of other co-existing types of Mammalia.

It is a fact worth noting, that of this assemblage of vertebrate remains, it is seldom that two or more bones of the same animal are found in juxtaposition, showing that they did not find their resting-place where the animals died, but have been floated, probably for long distances from the upper tributaries of the ancient Thames, and subsequently deposited in these fluviatile beds. But wherever the country, and whatever the distance or means by which they have been conveyed here, they have been subjected to no rolling nor water-wearing action; for all the angles and ridges of the bones still retain their original natural sharpness.

III.—ON THE REMAINS OF *RHINOCEROS LEPTORHINUS*, OWEN (*RH. HEMITŒCHUS*, FALCONER), IN THE COLLECTION OF SIR ANTONIO BRADY, F.G.S., FROM THE PLEISTOCENE DEPOSITS OF THE VALLEY OF THE THAMES AT ILFORD, ESSEX.

By THE EDITOR.

(PLATE XV.)

IN the late Dr. Falconer's Palæontological Memoirs[1] so ably edited by Dr. Charles Murchison, F.R.S., a masterly and critical examination is given of the European Pliocene and Post-Pliocene species of the genus Rhinoceros, from which we venture to extract the subjoined introductory remarks.[2]

"After examining all the collections in England and Italy, and those of Lyons, Montpellier, etc., I have come to the conclusion that there were four distinct Pliocene and Post-Pliocene species of Rhinoceros, three of which have long been confounded by Cuvier and other palæontologists under the name of *Rhinoceros leptorhinus*.

"I have carefully examined at Stuttgart the materials on which Kaup's and Jäger's *Rhinoceros Merckii* is founded. It is not a distinct species, but is identical with the Grays Thurrocks species, or *Rhinoceros leptorhinus* (*mihi*). The *R. Lunellensis* of Gervais is founded on a young jaw with milk-dentition, which is not to be de-

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[1] 8vo. London, 1868, vol. ii. p. 309.

[2] Compiled by Dr. Murchison from two letters addressed by Dr. Falconer in 1862 [illegible] Lartet, of Paris, and Col. Wood, of Stouthall, Swansea, and from his note

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two letters addressed by Dr. Falconer in 1862
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pended on for determining distinctions. So, also, the *R. elatus* of Croizet, and the *R. mesotropus* of Aymard, found in Auvergne, are not distinct species. I have examined the chief collections in Auvergne. The specimens in M. Pichot's collection and in the Museum of Le Puy are mainly *R. Etruscus*, while the *R. mesotropus* of Aymard comprises both *R. leptorhinus* and *R. antiquitatis*.

The four species may be classified as follows :—

PLIOCENE. I. No bony nasal septum.
1. *Rhinoceros leptorhinus* (Cuvier, *pro parte*).
Syn. *R. megarhinus* of Christol.
II. Partial bony septum.
2. *Rhinoceros Etruscus*, Falconer.
Syn. *R leptorhinus* (Cuvier, *pro parte*).
3. *Rhinoceros hemitœchus*, Falconer.
Syn. *R. leptorhinus* (Owen, *pro parte*).
POST-PLIOCENE. III. Complete bony septum.
4. *Rhinoceros antiquitatis*, Blumenbach.
Syn. *R. tichorhinus*, Fischer and Cuvier.

"1. *Rhinoceros leptorhinus.*—This is the original and typical *Rhinoceros leptorhinus* of Cuvier, founded on Cortesi's Monte Zago cranium. It is the species described by Christol as *R. megarhinus*, and is the only Pliocene or Post-Pliocene European species that had not a nasal septum.

"To this belongs the celebrated Cortesi cranium in the Museum at Milan, which I have carefully examined. With this species also I have identified the Rhinoceros remains found in the Sub-Apennine beds of Piacenza, in the Val d'Arno upper beds, at Montpellier and Lyons, and at Grays Thurrocks, in Essex. The Rhinoceros, however, found in the Elephant-bed of the Norfolk coast is different.

"2. *Rhinoceros Etruscus.*—This species, like the following, had an incomplete bony nasal septum, but it had a comparatively slight and slender form. It is met with along with *Elephas* (*Loxodon*) *meridionalis* and *Mastodon Arvernensis*. in the lower beds of the Val d'Arno, and in the 'Submarine Forest Bed,' or superimposed blue clays of the Norfolk Coast, immediately underlying the Boulder-clay ; but as yet it has been found in none of the ossiferous caves of Britain. With this species, also, I have identified the remains of a Rhinoceros submitted to me by Professor Ansted, which were found a few miles from Malaga, in white marl overlying Pliocene blue clay abounding with shells.

"3. *Rhinoceros hemitœchus.*—This species has been described by Professor Owen as *R. leptorhinus*. It has the nasal septum incomplete in the centre, and it differs from *R. antiquitatis* (*R. tichorhinus*) in other cranial characters, as well as in those of the teeth. I am satisfied on this point, after examining the entire dentition of both young and old animals. *Rhinoceros hemitœchus* accompanies *Elephas antiquus* in most of the oldest British bone-caves, such as Cefn, Durdham Down, Minchin Hole, and other Gower Caverns. It is also found at Clacton in Essex, and in certain beds in Northamptonshire. It is also met with in Italy.

"From some of these localities entire skulls and a great portion of the skeleton have been obtained.

"4. *Rhinoceros antiquitatis* (*R. tichorhinus*). This species had a complete bony nasal septum. It is found in the newer Pliocene deposits of Kent, Surrey, and Essex, and associated with *Elephas primigenius* in caverns of the same date.

"*Elephas antiquus* with *Rhinoceros hemitœchus*, and *Elephas primigenius* with *Rhinoceros antiquitatis*, though respectively characterising the earlier and later portions of our period, were probably contemporary animals; and they certainly were companions of the cave-bears, cave-lions, and cave-hyænas, and of some at least of the existing mammalia.

"There can be no reasonable objection to the name *Rhinoceros antiquitatis*. South of the Rhine, that is, in Geneva, France, and Italy, all modern palæontologists call the species *R. tichorhinus*; but, north of the Rhine, in Germany, Holland, Scandinavia, and Russia, the most eminent authorities designate it *Rhinoceros antiquitatis*.

"A name in science ought not to be a disputed point of mere geographical predilection.

"Blumenbach named it first *Rhinoceros antiquitatis*. Fischer de Waldheim, a palæontologist of no great authority, changed the name into *Rhinoceros tichorhinus*, and Cuvier adopted Fischer's name without acknowledgment. Desmarest called it *Rhinoceros Pallasii*. Blumenbach's names of *Elephas primigenius* and *Mastodon Ohioticus* are now accepted by every one; and there is no reason why his *Rhinoceros antiquitatis* should be rejected for a more modern name.

"Living neither north nor south of the Rhine, I have no geographical predilections, and as an impartial foreigner I accept the earliest name, viz. Blumenbach's; besides, the name *Rhinoceros tichorhinus* is faulty, inasmuch as three species had a nasal septum."

We make no apology for the length of the foregoing quotation, as it contains most valuable information as to the division and distribution of the fossil species of Rhinoceros in Europe, and has never appeared in any other of Falconer's works, save in his Memoirs, for which we are so greatly indebted to Dr. Murchison.

No better introduction could possibly have been found for the purpose of calling attention to the remarkably fine skull and lower jaw[1] of *Rhinoceros leptorhinus*, Owen (*Rhinoceros hemitœchus*, Falconer), obtained from the Uphall Brickpit in the vicinity of Ilford,[2] and probably the most perfect of this species which has hitherto been found in England (see Plate XV.).

It forms a part of the magnificent collection of Pleistocene Mammalian remains from this particular locality in the ancient Valley of the Thames, collected with so much care by Sir Antonio Brady, F.G.S., and for the preservation of which he and the public[3] are so largely indebted to the indomitable perseverance, energy, and scientific skill of Mr. William Davies, of the Geological Department of the British Museum, who rescued with his own hands this and many other equally unique and priceless remains from inevitable destruction, owing to the exceedingly friable nature of the fossils imbedded in this deposit of permeable and moist Brick-earth.

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[1] Found disassociated, but clearly referable to the same species, though possibly not to the same individual.

[2] See the accompanying sketch of the geology of the neighbourhood of Ilford, antè p. 390.

[3] This fine collection of Tertiary Mammalian Remains has since become the property of the Nation.

This species was heretofore only known in this country from exceedingly fragmentary remains, as, for example, the upper part of a skull and parts of lower jaws from Clacton and Walton, in Essex, (figured in Owen's British Fossil Mammals, pp. 356–381, figs. 131–141), and the basal portions of two crania and eleven rami of the lower jaw from the Gower Caves and Northampton (figured in Falconer's Palæontological Memoirs, vol. ii., plates 19-21 and 23-25.

Concerning the specimen from Ilford (Plate XV.), Mr. William Davies writes as follows:[1]—

"The skull is nearly entire, and evidently that of an aged animal; for the molars, of which there are six on each side, are all very much worn. The skull has not been crushed, and therefore shows well the normal form and proportions. The occiput is partly restored. The condyles and foramen magnum are entire, the basi-occipital is wanting. The parietal, frontals, and nasal bones are perfect. The last have a very rugose surface for the attachment of the nasal horn. The inter-orbital space is also slightly rugose, and probably supported a short frontal horn or boss. The zygomatic arches and styloid processes are perfect; the orbital rims are imperfect. The maxillaries are greatly mutilated, and the incisive bones are also imperfect, wanting the anterior ends by which they were united to the lower border of the nasal septum. The palate is nearly entire. Appended to the nasals is the anterior portion of the bony septum of the nares, perfect in front, but broken behind.

"The dimensions of skull are as follows:—Length of molar series 10·7 inch. Length of true molars 6·3 in. Length of pre-molars 4·4. Extreme length of skull from occipital crest to tip of nasals, measured along the curve, 33 in. Length from occipital crest to end of nasals in a straight line 31 in. Greatest constriction of skull between the zygomatic arches 5·1 in. Width of inter-orbital space 11 in. Width of nasals about the middle of the anterior rugosity 5·5 in. Extreme length of nasal opening, right side, 10·6 in. Width of zygomatic arches posterior to last molar 13 in. Width of zygomatic arches across glenoids 14 in. Width of occipital crest 4·6 in. Height of occipital crest from lower border of the foramen magnum 7·6 in. Width of condyles, including foramen magnum, 6·3 in."

Concerning the *cloison*, or bony septum dividing the nostrils, upon which Dr. Falconer in his classification (already quoted) lays so much stress, Mr. Davies contributes the following most important information:—

"In clearing the skull from its matrix of sandy gravel, I found the anterior border of the septum joined and apparently consolidated

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[1] Catalogue of Pleistocene Vertebrata in the Collection of Sir Antonio Brady, F.G.S., by William Davies, of the British Museum (p. 29). Printed for private circulation.

to the end of the nasals; but the greater part of that portion of the septum which is preserved, I found detached from these bones, *but not broken*; and this detached portion showed upon its superior margin a hollow smooth surface, which perfectly fitted a rounded longitudinal smooth ridge upon the inferior surface of the nasals, to which it was originally joined by an unanchylosed sutural attachment. Moreover, I traced the septum beyond the middle of the inter-orbital platform to which it was also attached, and served as a support. At this point, the bony septum was thick, but of a very coarse cancellated structure, and so exceedingly friable as to render it impossible to detach and preserve any fragment of this part of the bone. The septum became gradually thinner toward the front of the nasals, the structure becoming less coarse, to about the middle of the nasal apertures, where the bone is thinnest, but its substance more compact. It again thickens a little forwards and downwards, where it forms a broad inferior border to join the intermaxillary bones.

"During the process of restoring the skull, which was in a somewhat dilapidated condition, it was unfortunately necessary, in order to form a support for the palate and teeth, to cover the posterior portion of the septal sutural ridge with plaster, and thus destroy the evidence of its existence; but subsequently another skull of the same species was secured for the collection, in which this upper ridge is preserved and distinctly shown. There was also a central longitudinal ridge, but with a broken edge, upon the inner floor of the palate, to which bones I believe the septum was also attached; but owing to the broken condition of the palatal bones, and the displacement of the fragments, the fact of their being conjoined was not sufficiently noted by me at the time, so as to enable me to speak upon this point with absolute certainty."

The second cranium is not so perfect as that figured in our Plate XV. "Inasmuch as the molars, the premaxillæ, and the whole of the palatal portion of the skull are wanting. This fine fragment comprises the entire upper portion of the cranium. The occiput and condyles, the right zygomatic arch with the articulating surface, and the right orbit, with its anterior tuberosity, are also quite perfect. The two auditory foramina are present and entire. The styloid processes are broken, and the basi-occipital and sphenoid are mutilated, as are also the maxillaries, left zygoma, and orbit. The fragment, moreover, shows the anterior and posterior portions of the bony septum of the nares. The anterior portion is broken posteriorly, and is attached to a medial ridge, which ridge does not terminate at a short distance from the anterior border of the nasals, as in the typical Clacton specimen, figured by Prof. Owen in his 'British Fossil Mammals,' and which is now preserved in the British Museum, but is continuous along the under surface of these bones and of the inter-orbital platform, and unites with the posterior fragment of the septum, which is preserved and conjoined with the sphenoid."

[illegible]r. Davies remarks:—"The presence of these front and hind [illegible]s of the septal partition, with their broken inner margins, the coarsely cancellated bone found in the preceding specimen, and the continuous ridge, lead to the inference that" (contrary to the opinion of Dr. Falconer as already quoted) "the nares of this species were separated by an osseous division, the coarse structure of the greater part of which contributed to its speedy decomposition; the anterior portions, being of more compact texture, are found generally well preserved. Moreover, the inner edges of the portion of the septum which remain in this and the preceding specimen are jagged and broken, showing no trace of a true natural margin.

"The surfaces of the inter-orbital platform and of the posterior portions of the nasals are so slightly rugose in this specimen, that they may be described as nearly smooth, and as affording but small support for the basal attachment of either a nasal or a frontal horn; and as the cranial sutures are all consolidated, this comparative smoothness is not due to immaturity. The skull is of somewhat smaller dimensions than the preceding, and may probably be that of a female."

Concerning the jaw of *Rhinoceros leptorhinus* (figured with the skull on Pl. XV.), Mr. Davies observes:—"This is an exceedingly fine and nearly entire lower jaw, consisting of both rami, and containing the entire series of permanent teeth *in situ*, with the exception of the second premolar of the left side, of which the alveolus only is preserved. The anterior end of the symphysis is mutilated; otherwise each ramus, with its condyle and coronoid, is perfect. They are firmly connected at the symphysial suture, which is thoroughly consolidated. That the jaw pertained to an aged adult, is shown by the condition of the teeth, for they have all, even the last molars, been well worn. There are two mentary foramina in each jaw."

The dimensions are given as follows:—"Length of jaw 19 in. Height of ascending ramus to condyle 11 in. Height of ascending ramus to coronoid 12·5 in. Transverse length of condyles 4·5 in. Length of molar series 9·5 in."

We have to thank Mr. Davies most heartily for clearing up this obscure and difficult point, involving as it does the fundamental character upon which Falconer's species of *Rhinoceros hemitœchus* rests.

In the future Falconer's name (*R. hemitœchus*) must give way before Prof. Owen's *R. leptorhinus*,[1] not only as the older name, but also because Falconer's specific appellation "is faulty" (to quote Dr. Falconer's own words as to the abolition of *R. tichorhinus*, see *antè*, p. 400), "inasmuch as this species had a completely ossified nasal septum." From the observations of Mr. Davies it seems probable that the greater or less development of the bony nasal septum (upon which Dr. Falconer laid so much stress) cannot be relied upon as a basis of specific distinction between *R. Etruscus; R. leptorhinus*, Owen (*R. hemitœchus*, Falc.); and *R. antiquitatis*, Blum. (*vel R. tichorhinus*, Cuv.), although it may assist us, when preserved in fossil crania, to decide whether it was a horned, or hornless, Rhinoceros.

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[1] See Owen's History of British Fossil Mammals and Birds, London, 1846. 8vo., p. 356.

IV.—ON THE WEST INDIAN TERTIARY FOSSILS.

By R. J. LECHMERE GUPPY, F.L.S., F.G.S., etc.

(PLATES XVI., XVII., AND XVIII.[1])

§ 1. INTRODUCTORY REMARKS.

IN the GEOLOGICAL MAGAZINE (Vol. IV. p. 496) I have given some notes on West Indian Geology, with descriptions of a few new species of fossils. The notes were intended, in part, as supplementary to the papers published in the Journal of the Geological Society, and in the GEOLOGICAL MAGAZINE, on the Geology and Palæontology of the West Indies, and in part to exhibit an improved classification of the Caribean upper and middle Tertiaries.

Mr. Vendryes, an ardent naturalist and zealous collector of shells and fossils in Jamaica, has kindly forwarded to me a fine set of the Miocene fossils of that island. These have been in my possession for some time: but although several novelties are contained in the collection, want of time and opportunity has hitherto prevented my working them out. The high interest attaching to these fossils has, however, induced me to draw up descriptions of the new species, and to indicate those which, although previously described from other localities, are now for the first time added to the Jamaican list.

I propose now to give a list of all the organic remains hitherto found in the West Indies (as far as described) belonging to the subkingdoms Mollusca, Articulata, Echinodermata, and Protozoa. I do not enumerate the post-Pliocene fossils, as, for the most part, they are of existing species only. The Corals have been amply treated of by Prof. Duncan, F.R.S., in late volumes of the Journal of the Geological Society.[2] The columns of the table appended hereto are arranged in the order of the presumed antiquity of the deposits occurring in the localities named at their heads. I should remark that the observations of Mr. P. T. Cleve and others, as well as my own, lead me to substitute the term "Eocene" for the term "Lower Miocene," hitherto employed for the Manzanilla and San Fernando beds in Trinidad, and for certain deposits of similar age discovered by Mr. Cleve in St. Barts.

There are yet a considerable number of undescribed fossils known from Haiti, of which there are examples in the Museum of the Geological Society. There is little doubt that very many of the blanks in the table now given will be filled up after further search. It is probable that most of the Miocene mollusca will, sooner or later, be found in nearly all the localities where formations of that age exist in the Caribean area; though various local circumstances, such as depth and clearness of water, conditions favourable, or the reverse, for preservation of organic remains, or those of particular kinds, must be allowed to have due consideration. The fossil fauna of the Eocene deposits which stands out as a group quite distinct from, though containing some species in common with, that of the Miocene deposits, will be found hereafter to have a very much larger number of species than we have hitherto noticed. In the San Fernando beds, whose age we now state as Eocene, are many mollusca whose condition is such that, although we may venture to assign to them their generic position, it would be unwise to describe new species from such imperfect material. As regards the Foraminifera, I believe that the differences between the faunas of the several deposits depend more upon bathymetrical conditions than upon anything else.

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[1] These three plates will appear with the concluding portion of the paper next month.—Edit. GEOL. MAG.

[2] *See Quart.* Journ. Geol. Soc., vol. xix. p. 406 and p. 613; xx. p. 20 and p. 358; *xxi. p. 1;* and xxiv. p. 9.

The determination of the geological age of the Jamaica beds and of the remarkable relations of the fossil fauna of the West Indian Miocene to that of Europe and the living fauna of the eastern seas, is strikingly supported by the new fossils now described. We have a *Murex*, an *Ovulum*, a *Cassis*, and a *Fasciolaria*, whose nearest congeners are European Miocene and Asiatic recent; a *Scalaria*, previously described indeed, but from inadequate material, whose relations are similar, and a *Naticina*, a genus almost extinct in the West Indies, but whose present distribution is along the path pointed out as that of the migration of organized beings during the Tertiary period from America to the Pacific Ocean through North Africa and South Europe.

Among the Jamaica shells there are few, e.g. *Turbo castaneus*, *Strombus pugiloides*, and *Plicatula vexillata*, which, like the *Conus fuscocingulatus* of the European Miocene, retain traces of the colouring which ornamented them while living. It is only where the strata are of such composition as to be extremely favourable to the preservation of molluscan remains, that such a circumstance could occur. In Jamaica and Haiti the Miocene formations have been remarkably suited to this end, and hence we have from them a series of organic remains scarcely surpassed in beauty even by those of Bordeaux, Dax, or Paris. In Trinidad the shells of similar age are for the most part extremely altered, and their characters more or less obliterated. It is therefore fortunate that we have those of Haiti and Jamaica upon which to found and rectify our determinations of the Trinidad rocks and fossils of like age.

§ II.—Description of the Fossils.

Hyalæa (Diacria) Vendryesiana, Pl. XVII. Figs. 2*a*, 2*b*.

Shell elongate, smooth; both valves somewhat inflated, but the superior one more so than the other: terminated on each side by two sharp mucrones, and posteriorly by a narrow curved mucro not so long as the body or main portion of the shell. Lips everted, the inferior one bordered exteriorly by a raised ridge, which towards the lateral mucrones gradually becomes confluent with the edges of the lips. Length 5 mm., of which the terminal mucro forms about 2. Breadth nearly 3 mm.

Related to *H. inflexa* and *labiata* of D'Orbigny.—It differs chiefly in being more inflated, especially the inferior valve, and in being narrower behind the lateral mucrones—a character, it would seem, of some importance in this genus.

The length of the terminal portion of the shell seems to be relied upon as the distinction between *Diacria* and the more typical members of the genus *Hyalæa*. The present species belongs to *Diacria* on account of this character.

Scalaria Leroyi, Guppy, Pl. XVI. Fig. 10, and Pl. XVIII. Fig. 2.

Proceedings of the Scientific Association of Trinidad, 1867, p. 168.

Turreted, cylindric, many-whorled, cancellated by numerous transverse and spiral costellæ, except on the base, which is spirally striate only. Aperture suboval. Pillar-lip somewhat everted, forming a callus on the columella. Outer lip simple, sharp, a little dilated anteriorly. Whorls regularly rounded, suture deeply sunk.

My original description of this shell was drawn up from an examination of the specimens found in Trinidad, which are so much altered by fossilization that the character of the surface is not determinable. The examples from Jamaica are in good preservation, though they are not so large as those found in Trinidad, one of which is more than six inches long. Some of the specimens from Jamaica exhibit a variation in the character of the surface, which might induce a belief that there are two species. I do not, however, take that view. One beautiful example has the transverse costellæ larger and more distant than the spiral ones, the latter being threadlike and rising upon the former. In this example the spiral striation of the base is also more marked. *Sc. Leroyi* may be compared with *Sc. magnifica*, Sow.; but there are points of resemblance between it and *Sc. decussata*, *raricosta*, and *lineata*. None of the recent West Indian species bear any resemblance to the fossil except in that general shape which is common to nearly all the members of the genus. On the whole, however, the nearest ally of the Jamaican fossil may perhaps be found in *Sc. tenuistriata*, Orb. (Bahia Blanca).

Ringicula tridentata, n. sp.

Ovate-conic, moderately thick, smooth, shining. Spire conic. Whorls about 4. Aperture suboval: columella thickened and bearing two strong spiral plaits, the callus continued backward, and carrying a stout tooth on the body-whorl; the latter separated by a deep notch or canal from the thickened and somewhat everted outer lip. Length nearly 2 mm., breadth about 1.

Distinguished from *R. semistriata*, Orb. (Cuba Shells, vol. ii. p. 103, pl. xxi. f. 17–18), by a wider mouth and less thickened outer lip. *R. tridentata* does not exhibit any trace of the striation which marks the anterior portion of *R. semistriata*, which was described by D'Orbigny as a recent shell from Jamaica.

Naticina regia, n. sp. Pl. XVII. Fig. 6.

Oval oblong, spirally striated by fine equidistant grooves, which are crossed by a few rather irregular lines of growth. Whorls about 5, the last very large. Spire short, acuminate. Aperture semioval, rather narrowed above. Umbilicus round, very partially [illegible]n by the everted columella callus. Outer lip sharp, indisdentate. Length 15 mm., breadth nearly 10.

Closely akin to *N. Lamarckiana*, from which it is distinguished by its narrrower mouth. It is almost as near to *N. papilla* (Africa), but it is less elongate in its proportions.

Bulla Vendryesiana, n. sp. Pl. XVI. Fig. 6.

Rimate, rather cylindrical-ovate, solid, smoth. Spire deeply sunk. Aperture longer than the shell, dilated anteriorly. Inner lip covered with a callus which is everted over the narrow umbilicus, and extends backward to the canal separating the body-whorl from the sharp outer lip. Length about 15, breadth about 9 mm.

Allied to *B. striata*, Brug., particularly to that form called *B. maculosa*, Mart. The surface of the fossil is not well preserved, and does not admit of an exact description of its characters. *B. Vendryesiana* is rather more cylindrical in shape than *B. striata*, and from *B. maculosa*, to which it is nearer in figure, it is distinguished by its greater solidity and its thicker and more everted columella callus.

Tornatina coixlacryma, Guppy.

Geological Magazine, 1867, Vol. IV. p. 500.

Tornatella textilis, n. sp. Pl. XVII. Fig. 4.

Oval-oblong, solid, a little ventricose, closely cancellated by numerous spiral riblets and finer longitudinal threads most distinct in the spiral grooves. Spire short, conic. Whorls about 7. Aperture elongate, narrow, dilated anteriorly into a canal. Columella twisted, bearing a single stout fold. Outer lip sharp, finely dentated by the spiral riblets. Length 17, breadth 9 mm.

In shape this shell approaches *T. fasciata*. It is of more solid structure, its spire is somewhat shorter, and it is at once distinguished by its cancellated surface.

Cylichna ovum-lacerti, Pl. XVIII. Fig. 22.

Shell small, cylindrical-subovate, minutely striate transversely; spire small, sunken; aperture as long as the shell, dilated anteriorly; outer lip straight, blunt; columella callus with a strong tortuous fold.

Lower Miocene, Trinidad.

Turbonilla turris, Orb., Pl. XVIII. Fig. 15.

Chemnitzia turris, Orb., Moll. de Cuba, pl. xvi. f. 10–24.

Other forms of this species are distinguished specifically by D'Orbigny as *C. pulchella*, *C. ornata*, and *C. modesta*.

These and other varieties are common in the Matura Beds, Trinidad.

Aclis helecteroides, Pl. XVIII. Fig. 11.

Shell turreted, cylindric, many-whorled, shining, whorls slowly increasing, impressed with a deep groove below the suture, which is equally deep, forming a spiral thread; aperture sub-circular, columella slightly reflexed, peristome simple.

Pliocene, Trinidad. It resembles a *Proto*, but the columella prevents its reference to that genus. I refer it to the genus *Aclis* provisionally only, as I think it will be found to be the type of an undescribed genus.

Leiostraca clavata, Pl. XVIII. Fig. 16.

Shell rather club-shaped, whorls smooth, flattened, the last forming more than ⅓; spire acuminate, suture linear, scarcely impressed; aperture suboval, elongate, narrow above, dilated in front; peristome simple, columella somewhat reflected and thickened.

Pliocene, Trinidad. Allied to *L. acuta*

Turritella planigyrata, Pl. XVIII. Fig. 5.

Conic-cylindric, striate by fine spiral lines, whorls very slightly convex, the later ones nearly flat; aperture sub-quadrate.

Miocene, Trinidad. A very distinct species, remarkable for its almost entire want of ornamentation, and the flatness of its whorls.

Vermetus trilineatus, Pl. XVIII. Fig. 12.

Conic-cylindric, turreted, spire pointed, whorls flat, bearing three narrow spiral keels; lower whorls irregular; suture distinct, linear shallow.

Pliocene, Trinidad. The young shell is not to be distinguished from a small *Turritella*, but the subsequent growth supplies the Vermetiform character.

Triforis guttata, Pl. XVIII. Fig. 27.

Reversed, cylindrical; whorls about eight, zoned with three spiral lines of small obtuse points which are connected spirally and longitudinally by threads; suture impressed; base with three or four strong striations; aperture produced into a canal; peristome produced, inner margin with a narrow defined callus.

Pliocene, Trinidad. Allied to *T. ventricosus*, Gmel.

Solarium semidecussatum, Pl. XVIII. Fig. 14.

Small, orbicular depressed, strongly decussate on the upper surface, nearly smooth on the lower surface; umbilicus deep, its margins crenate and spirally striate.

Pliocene, Trinidad. It is with some doubt that I refer this species to the genus *Solarium*.

Cancellaria scalatella, n. sp., Pl. XVII. Fig. 4.

Turreted, umbilicate, spirally striate by numerous close spiral threads more elevated on the stout rounded longitudinal variciform ridges, of which there are six or seven on a whorl. Suture very deeply sunk. Whorls about seven, slightly rounded, angulate and crowned above by the ridges. Aperture almost triangular, rounded above, angular and formed into an obsolete canal anteriorly. Outer lip sharp, grooved within. Inner lip continuous, thin, sharp, slightly reflected and bearing two folds. Base angulate, perforated by a small round umbilicus.

Related to *C. varicosa*, Brocchi (Miocene, Piedmont); but smaller, and of somewhat stouter figure. The spiral striæ are coarser, and the peristome is finely grooved instead of being coarsely dentate only. In *C. varicosa* the spiral striæ are crossed by very fine ngitudinal ones, which do not exist in *C. scalatella*. The most king difference, however, is that the whorls are rounder, and the suture much more deeply sunk in *C. scalatella*, whilst the longitudinal ridges project upon the angle of the whorls so as to give a coronate appearance.

The three *Cancellariæ* hitherto described from the Jamaican Miocene are all akin to European fossils of the same date; but two of them belong to the type of the recent *C. reticulata*. The present is of more decidedly Miocene aspect than either of the three previously described.

Ovulum immunitum, n. sp., Pl. XVI. Fig. 7.

Fusiform-elongate, pointed at both extremities. Outer lip thickened, extending in a nearly regular slight curve from the posterior to the anterior canal; slightly dilated anteriorly. Inner lip with two strong folds at the anterior end. Aperture as long as the shell; narrow posteriorly, growing wider gradually until near the middle of the whorl, then increasing in width by the expansion of the outer lip and the recession of the whorl to form the slightly twisted pillar-lip. Length about 20, breadth about seven mm.

Allied to *Ov. Leathesi*, Wood, of the English Crag. It is nearly of the same size, but is more slender in its proportions, and in some particulars is more close to *Ov. spelta*, including under that term both the fossil and recent species so called.

Conus recognitus, Guppy.

C. solidus, Sowerby, Journ. Geol. Soc., vol. vi. p. 45.

C. recognitus, Guppy, Proc. Scient. Assoc. 1867, p. 171.

The name *solidus* having been used for another Cone, I proposed in 1867 the name of *recognitus* for this species.

Conus consobrinus, Sow., Pl. XVII. Fig. 4.

Sowerby, Journ. Geol. Soc., vol. vi. p. 45.

I have referred this shell to Sowerby's species; but if my determination be correct, Sowerby's description is in need of amendment. The zones, or rather spiral ribs, can scarcely be called granose, although they exhibit a tendency to become so towards the completion of the last whorl, which is usually devoid of the tubercular crowning of the previous whorls.

This species was hitherto only known from Haiti, but it is now added to the Jamaican list.

Conus prototypus, Pl. XVIII. Fig. 1, and Pl. XVII. Fig. 9.

Somewhat pyriform, finely striate anteriorly, becoming quite smooth on the angle of the whorls, which bear a rather indistinct keel; spire mucronate, rather elevated; aperture somewhat widened towards the anterior canal.

Miocene, Trinidad. A cone which departs very considerably from the usual type in its swelling outlines and the consequent direction and shape of the aperture. It is more of the shape of *C. bulbus* than of any other species I know. It is, however, probably a young specimen.

Mangelia micropleura, Pl. XVIII. Fig. 6.

Subfusiform, longitudinally ribbed, the ribs crossed by numerous striæ, of which a prominent one forms an angle on the upper part of the whorls; last whorl longer than the spire; aperture rather narrow, lanceolate, with a sinus on the posterior part of the thickened peristome.

Pliocene, Trinidad. Allied to *M. pulchella*. The ribs vary considerably as to size and distance apart.

Purpura miocenica, n. sp., Pl. XVI. f. 9.

Subpyriform, rather ventricose above, rimate, narrowed and produced anteriorly, adorned with longitudinal ribs (about 10 to the whorl), which are crossed by coarse rugose high narrow spiral ridges or threads. Whorls about six, apex acuminate. Pillar-lip smooth, reflected over the shallow umbilical fissure. Canal produced. Outer lip sharply dentate by the spiral ridges. Length about 22, breadth about 15 mm.

The outer layer of the shell is usually removed, and where this is the case, each spiral rib appears to be double; but when the outer surface is preserved, the somewhat foliated or echinated rugosities of these ribs are very obvious.

This is a *Coralliophila*, and is related to the *P. galea* (Chemn.) of D'Orbigny, of which the name ought probably to be *P. plicata*, the appellation *galea* being the rightful property of a closely allied East Indian shell. Another form with which the Jamaican fossil may be compared is *P. squamulosa*, Reeve.

Fasciolaria textilis, n. sp., Pl. XVI. Fig. 5.

Elongate, fusiform, closely cancellated by numerous spiral ridges from one to two mm. distant, between which are (especially anteriorly) one, two, or three finer threadlike ribs; and by numerous closer and smaller longitudinal lines. Whorls six, the first two of which are smooth, the apex deciduous and usually wanting, the last more than two-thirds of the shell, rather ventricose above the middle, produced and rather attenuated anteriorly; bearing on the upper half 5–7 elongate rounded tubercular prominences. Columella margin with three strong tooth-like plaits. Interior of peristome smooth. Length nearly 70 mm., breadth 30.

The cancellation gives to the surface an appearance like that of coarse cloth or bagging. This species should be compared with the *F. intermedia* of Sowerby, from the Haitian Miocene. It bears a resemblance to *F. filamentosa*, but is shorter, stouter, and less angular in all its features except only the tubercles, which are disposed in similar fashion, but are perhaps somewhat larger and more elongate. It is very different from *F. Tarbelliana*, Grat., which occurs at Cumana in Venezuela, as well as in Chili and Europe. *F. textilis* exhibits the close alliance of the genus to *Turbinellus*.

Phos erectus, n. sp., Pl. XVI. Fig. 1.

Solid, turreted, conic-cylindric, finely striated longitudinally, and adorned with stout longitudinal variciform ridges, which are highest the angle of the whorls, become obsolete at the shallow suture, l are twisted at the base: coarse spiral threads cross the longi-iual grooves and ridges, rising on the latter into low scarcely iceable tubercles. Whorls about nine, increasing very gradually, ;htly angulated, the last forming more than one-half the length the shell. Aperture rather narrow. Columella twisted, bearing spiral plait. Outer lip simple, having 12–15 entering grooves, furnished with a small sinus near the anterior canal; joined teriorly with the body-whorl by a callus. Length about 21, adth about 10 mm.

Columbella peculiaris, Pl. XVIII. Fig. 20.

ylindric-suboval, often a little distorted; whorls six, slowly in-ısing, the last forming about ½; spire obtuse; suture somewhat gular or dentate; aperture small, pointed above, peristome simple, umella simple, truncate.

liocene, Trinidad. Perhaps allied to *C. clausiliformis*, Kien., but shorter and more ventricose figure.

Planaxis crassilabrum, n. sp., Pl. XVIII. Fig. 13.

onic-oblong, somewhat flattened, smooth; spire conic; outer lip tate, much thickened and somewhat everted; columella flattened, dly truncate, spirally striate; anterior canal short, open; posterior al narrow, separated from the body-whorl by one or two stout th.

liocene, Trinidad.

(*To be concluded in our next Number.*)

NOTICES OF MEMOIRS.

RECHERCHE GÉOLOGIQUE DE LA SUÈDE.—"Description de la formation Carbonifère de la Scanie." By EDVARD ERDMANN. With a geological map and 4 plates of plans and sections. 1874.

HIS Memoir is published in a bilingual form, the French translation, which precedes the Swedish text, being somewhat idged. This Coal-bearing formation in Scanie is said to be of ssic age, the true "Carboniferous" being entirely absent. The er rocks of the district are, crystalline rocks, gneiss, etc.; the nbrian formation, to which are referred certain quartzites; Lower urian, which include alum-shales, Orthoceratite limestone, and illaceous schists. The Upper Silurian is also represented by estones and schists, the former rich in fossils, but the schists so e those of the Lower division that they are represented by one our on the map. The next following beds are Red Sandstones l shales, probably of Triassic age, but no unconformability to the per Silurian has been detected as yet; in fact some of these Red dstones were referred by Murchison and Angelin to the Upper urian; no fossils have been found in them. On these red beds ow directly the Coal-bearing (Jurassic) strata. But probably Hör sandstone should be intercalated here, although not found direct relation to any of the former stratified beds, for, from the fossils which it contains (Cycads, Ferns, etc.), it is supposed of the age of the commencement of the Lias, and hence to come between the Coal-beds and the Red Sandstone: petrologically, much of the Hör Sandstone is indistinguishable from some of the grits of the Coal-bearing strata. Above these latter come the Cretaceous beds.

The Coal-bearing beds contain clay-iron-ore and some very good refractory clays. The beds of Coal themselves vary from less than a foot to three or four feet. There are several beds in the section, but denudation seems to have removed some of them in different localities, so that few are worked in any one place. The thickness of the formation varies much; in one place they bored 600 feet without getting out of the Coal-beds. The shafts are mostly shallow, and the beds much interrupted by small faults.

The most important locality in a Coal-producing point of view is Höganäs; only two seams, however, are much worked there, viz. the two lowest in the formation; higher up the beds get poorer. The dip of the Coal-strata is mostly at a very low angle, or nearly horizontal. The quality of the Coal seems to differ much; even in the same bed there may be two or three kinds separated by thin partings; the better sorts are said to be quite as good as English Coal for most economic purposes. The method of working has been by *pillar and stall*, but of late the *long wall* system has been introduced. In 1871 the output from the four chief localities was 1,992,590 cubic feet.

The precise age of these Coal-beds is not quite settled. Prof. Hébert considers them of the age of the Lias. Among its fossils are, *Amphidesma donaciforme*, Phill.; *Avicula inequivalvis*, Sow.; *Pecopteris Beckii*, Brongn.; and Cycads. Prof. Torell notices the affinity of the flora to that of the Yorkshire Jurassic beds, and mentions the occurrence of *Solenites Murrayana*, L. and H.

REVIEWS.

I.—UNITED STATES GEOLOGICAL SURVEYS.

1. Reports of the United States Geological Survey of the Territories for the Years 1867–69. Reprint, 1873.
2. Report of the Geological Survey of Wyoming and Portions of Contiguous Territories. 1871.
3. Final Report of the Geological Survey of Nebraska and Portions of the Adjacent Territories. 1872.
4. Sixth Report of the Geological Survey of the Territories, embracing Portions of Montana, Idaho, Wyoming, and Utah. Washington, 1873.
5. Contributions to the Extinct Vertebrate Fauna of the Western Territories. By Joseph Leidy. Washington, 1873.

THE above volumes form only a portion of the results of the Survey under the direction of Prof. F. V. Hayden, but they fully attest the energy and zealous co-operation which has been brought to bear on the Survey by himself and his able colleagues, since its commencement in the present form in 1867. We have previously noticed some of Dr. Hayden's researches (Geol. Mag. Vol. VIII. p. 32), and the above Reports, with the exception of No. 1, which is a reprint, are further valuable contributions to the geology of the north-west districts explored. Besides the special geology, they contain remarks on the physical features, notices of the various economical substances, descriptions of the fossils, together with catalogues of Mammals, Shells, Insects, and Plants, collected during the expeditions.

The Sixth Report (No. 4) is full of interesting matter, and well worthy of the study of the European geologist, both as regards physical geology and palæontology. It includes descriptions of the Yellowstone Valley, and adjacent country,—the cañons, the thermal springs, the geyser basins, etc. The formations noticed are Gneiss, Silurian, Carboniferous, Jurassic, Cretaceous, and Tertiary. These strata are described by Mr. A. C. Peale as well seen in the Gallatin cañon, situated between the two great rivers, the Yellowstone and the Madison, which is a continuous gorge cut by the river for more than seventy miles, with walls rising on either side from 1000 to 2000 ft., exposing a geological section which has hardly a parallel in the North-west.

The student of 'Earth Sculpture,' conversant with the enormous amount of denudation which certain areas of Great Britain have undergone, will read with interest the following lines in Dr, Hayden's Report, p. 43:—"The evidence becomes stronger every year of exploration that the erosive forces have acted on a more stupendous scale than I had ever conceived or expressed in any of my former Reports; that the entire series of sedimentary strata, from the lowest Silurian to the highest Tertiary known in the west, has extended in an unbroken mass all over the North-west; and we find here and there, by the exposure of the entire series, as at Cinnabar Mountain, and in many other localities, the most satisfactory proof of the statement which I have so often made. This single statement implies that from 10,000 to 15,000 feet in thickness of unchanged rocks have been removed from this mountain region, except what might be called remnants left behind, occupying restricted areas. The older the group, the larger the area over which it has escaped erosion. The hard and compact limestones of the Silurian and Carboniferous ages are found to a greater or less extent all over the North-west. They yield much less readily than the more modern beds, and are consequently found on the summits of the highest mountains, 10,000 and 12,000 feet above the sea."

Again, the geologist conversant with the evidence of contemporaneous volcanic action in the Tertiary period of the British Islands, as seen in Northern Ireland, Scotland, and the Western Isles, so fully described by Prof. Geikie and Mr. Judd, will find a parallel in the proofs of similar volcanic activity, and apparently of the same age, intensity, and extent, in the Western territories of the States. Dr. Hayden remarks: "I am now inclined to believe that when our western country is more thoroughly explored by competent geologists, it will be found that the area covered with volcanic rocks is far greater than we have *hitherto* suspected. Like the more modern

Tertiary beds, the basalts and conglomerates of volcanic origin have been subject to terrific erosion, and only a portion of their wonderful magnitude is left behind. So far as my own explorations have extended, the main portion of the volcanic material of the West has been thrown out at a comparatively modern date. Among the Cretaceous and Coal-bearing groups are irregular interstratified beds of basalt, but the great mass of trachyte, basalt, and volcanic conglomerates, seems to have been erupted since the surface attained pretty nearly its present configuration. The conglomerates, although in some instances reaching a thickness of 3000 feet at least, do not seem to have been disturbed to any great extent since their deposition. The position of the trachytes, which have overflowed the mountain ranges, indicates that they could not have been very ancient, perhaps not older than later Miocene or early Pliocene, while the true basalts are extremely modern, approaching closely to our present era." (p. 44.)

One of the principal objects of the Survey has been to collect evidence bearing on the relations of the Cretaceous and Tertiary strata to each other, for considerable difference of opinion has arisen as to the true age of the beds at the summit of the former and the base of the latter strata. The above strata, with the exception of some Carboniferous and Permian rocks, are extensively developed in Nebraska north and south of the Platte River, as shown in the Report (No. 3). The Cretaceous rocks are divided into the Dakota, Benton, and Niobrara groups in the lower series, and the Fort Pierre and the Foxhills group in the upper series. Above these is the Fort Union or Lignite group, which, with some other beds, Dr. Hayden has termed "transition beds," as they indicate a passage from marine to lacustrine conditions.

In Nebraska these lignite beds, with great numbers of dicotyledonous leaves, are doubtfully placed as Eocene (p. 93), and are overlain by the Wind river and White river group referred to the Miocene, and the Loup river beds, with freshwater and land types, to the Pliocene period. The problem of the relations of the Cretaceous and Tertiary and Transition strata, has been approached (at Dr. Hayden's request) by Profs. Leidy and Cope, through the extinct Vertebrate fauna, by Mr. Lesquereux through the Fossil flora, and by Mr. F. B. Meek through the study of the Invertebrata. These papers, printed in the above Reports (Nos. 2, 3, 4), although to some extent preliminary, are full of valuable and suggestive remarks, well worthy the study of the European palæontologist, and as showing, from each author's stand-point of view, the age of the formations under discussion. The subject is further supplemented by the splendid memoir, "On the Extinct Vertebrata of our Western Territories," by Prof. J. Leidy (No. 5 of the above list), containing descriptions of 125 species of mammals, reptiles, and fishes, and forming the first part of vol. i. of the quarto series of reports which are intended to embody the more original and technical results of the Survey.

The study of the fauna and flora of these different formations [illegible]s somewhat discrepant results, for, as remarked by Professor esquereux, "it is especially from our flora of the Lower Cretaceous he Dakota group) that we have a vegetable exposition peculiarly variance with that of Europe at the same epoch, and whose types much resemble those of the European Tertiary that the evidence the age of the formation, where the plants have been found, could ot be admitted by palæontologists until after irrefutable proofs of had been obtained." (No. 2, p. 378.) The Dakota flora consists iefly of dicotyledonous leaves of genera to which belong most of the ving arborescent plants of the American continent and of its pre- nt climate, as *Liquidambar*, *Salix*, *Betula*, *Liriodendron*, *Magnolia*, *uercus*, *Sassafras*, etc., and what is noticeable is the almost entire sence in this group of any kind of serrate leaves. Prof. Lesquereux lso remarks, "There is also in the flora of the Eocene of the Rocky ountains a marked preponderance of leaves with entire borders. he serrate leaves appear in the Miocene, with *Acer*, *Alnus*, *Corylus*, id become predominant in the Pliocene of California, where *Ulmus*, *lanera*, *Celtis*, *Carya* abound, though these genera are not more in ie flora of the Pacific Slope."[1]

The Benton, Niobrara, Pierre and Foxhills groups are undoubtedly retaceous, but the Fort Union or Lignite group, which is largely eveloped in the North-west, is somewhat debateable ground, for though usually regarded as Tertiary from its flora, Prof. Cope says the beds in the Missouri valley: "The presence of the orders *auropterygia* and *Dinosauria* establishes conclusively the Cretaceous id Mesozoic character of that fauna."[2]

M. Lesquereux and Dr. Newberry consider this series of beds as of ertiary age, and some of them to be as high as the Miocene. Prof. ope regards the evidence derived from the Molluscs in the lower eds, and the Vertebrates in the higher, as equally conclusive that ie beds are of Cretaceous age. There is, then, no alternative but accept the result, *that a Tertiary flora was contemporaneous with Cretaceous fauna, establishing an uninterrupted succession of life* ross what is generally regarded as one of the greatest breaks in ologic time.[3] As bearing on the subject of the Lignitic formation nsidered as Eocene, Prof. Lesquereux remarks: "The presence of ep marine species in strata overlying remains of more recent ones dicates a local subsidence which should be considered as an ex- ptional case, unimportant indeed in comparison to the persistence general characters. . . . . Shall we admit as Cretaceous all ese land formations bearing from top to bottom evident Eocene aracters, on account of some isolated Cretaceous deposits locally read over them; or shall we consider the whole presenting general aracters positive enough to force its separation into a new group, id call it Eocene? . . . . We do not, and cannot call the Coal-measures either Devonian or Permian, on account of some fossils mixed in their strata, and identical with species of these different formations. Would it be rational to admit that Eocene shells and Eocene plants under the strata bearing Cretaceous fossil remains may be so-called Eocene colonies descended into the Cretaceous, and that the lignite beds underlying them represent an escaped member of the Eocene, bearing, as it does, in its flora, its compounds, etc., Eocene characters; and that these Eocene members have become of Cretaceous age by the only reason that some Cretaceous fossils are seen over them? As legitimate would it be, I think, to admit our present epoch as Cretaceous from the animals of Cretaceous types brought up by deep soundings from the bottom of our seas." (Report, No. 4, p. 342.)

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[1] Bulletin of the U.S. Geol. and Geogr. Survey of the Territories, No. 2, p. 61.

[2] *Ibid.* p. 7. In a communication to the Academy of Natural Sciences, Phila- lphia, Jan. 20 and 27, 1874, Prof. E. D. Cope has further corroborated the etaceous age of the lignite-beds of North-east Colorado and Fort Union by the covery of remains of *Dinosauria* (*Hadrosaurus*, *Polyonex*, etc.), as well as of rtoises and Crocodiles.

[3] Ibid. p. 16.

Prof. Leidy's work (No. 5), already alluded to, is chiefly occupied with descriptions of the Tertiary fossil vertebrata, and there is an interesting section on the Cretaceous vertebrates. Two genera of Birds described by Prof. Marsh, from Kansas, under the names of *Ichthyornis* and *Apatornis*, are the most remarkable of their kind. They have biconcave vertebræ, and the jaws are furnished with teeth. Other Cretaceous birds described by the same author are *Hesperornis*, allied to the *Colymbidæ*, *Graculavus*, related to the Cormorants, and a new wading bird. *Palæotringa vagans*, from the Greensand of New Jersey. In remains of reptiles and fishes the western Cretaceous formation abounds. Among the reptiles are some of the largest and most wonderful of their kind, represented by great turtles allied to *Atlantochelys*; numerous species of *Mosasaurus* and closely related genera; the *Polycotylus* and the long-necked *Discosaurus*, allied to *Plesiosaurus*; and *Pterodactyls*, with enormous expanse of wings. This important contribution to extinct organisms will be followed by a second volume on the same subject by Prof. E. D. Cope, whose review of the Cretaceous vertebrata will be found in the Bulletin before quoted. J. M.

II.—GEOLOGICAL SURVEY OF VICTORIA. (Melbourne, 1874.)

THE first Part, by Mr. R. Brough Smyth, contains an account of the progress of the Survey since the last Report, from which it appears that the areas surveyed and coloured up to the present period include the Sandhurst, Ballarat, and Beechworth gold-fields, the Cape Otway and Cape Patterson coal-fields, and the Grampians and Glenelg districts. With regard to the Coal-fields, it appears that though thick seams were believed to exist, more recent investigations have shown that no workable seam of any thickness has been opened in any part of Victoria. The statements made in this respect in the Reports of the Board (pp. 91–124) appointed to investigate the subject have been corroborated by Mr. John Mackenzie, the Government Examiner of Coal-fields, who, with Mr. Reginald Murray, has reinspected and measured the Coal-seams; so that Mr. Brough Smyth remarks, "There is no longer any doubt respecting the character of the seams of Coal which have been discovered up to the present time. Not one of them, with wages as they are at present, is workable. It remains to be considered whether the lower beds of this formation, with which in the neighbouring colonies thick seams of Coal are associated, are likely to be discovered in Victoria." (p. 23.) The flora of these Coal-fields, briefly alluded to in this Report, is interesting, from its Mesozoic facies, while in some cases, in Tasmania, New South Wales, and Queensland, with a Mesozoic flora, the associated marine fauna is of Palæozoic type. One point of interest is mentioned with regard to the genus *Glossopteris* (a well-known Australian Coal-fern), that it is usually characteristic of the lower and thicker seams of Coal, but no trace of it has been found in Victoria. A table of fossils by Prof. McCoy is given at p. 33, of the more common and characteristic types, the greater number of which have been discovered in the colony; although determined by him, they have not yet been published. Allusion is also made to some fossil fruits discovered about three years ago in an auriferous *lead* at Haddon, near Smythesdale, and described and figured by Baron von Mueller (in the Quarterly Reports of the Mining Surveyors), who infers from these remains "that during the later Tertiary period a portion of the western district of the colony was an archipelago, with here and there a few active subaerial volcanos, and enjoying a warmer climate than that which now prevails, and having on the land surfaces a vegetation somewhat of the character of that found in the north-eastern parts of Australia."

The second Report is on the Mineral Resources of Ballarat, by Mr. Reginald Murray, including an account of the various formations, their characteristics, and the observed facts connected with them interesting to the miner and scientific inquirer. The rocks of Ballarat are Granite, Lower Silurian, with auriferous quartz reefs, and the Tertiary gold drifts. There are four clearly defined epochs of gold drift in the Ballarat district.

1. The 'oldest' period included the deposit of drifts clearly antecedent to the time at which the lead-channels were eroded to their present depth.

2. The 'older' period embraced the deep-lead drifts, those intervening between the lava flows and the lava flows themselves, the uppermost lava flow closing the period.

3. Deposits of 'recent' age are those which were deposited immediately after the uppermost lava flow.

4. 'Most recent' drifts are those in recently eroded gullies, or such deposits of clay, sand, and gravel as have accumulated subsequently to the 'recent' period, and form coverings over the other deposits.

These auriferous deposits show the amount of denuding action which disintegrated the quartz reefs during the various drift periods. For, although a large proportion of the alluvial gold was probably disintegrated from its matrix during the 'oldest' period; as the *lead* channels were eroded, the 'oldest' gravels were in a manner sluiced down, and their gold re-deposited in the river-beds, together with the fresh *supply from* the further disintegration of the Silurian *rocks.*

The three great *lead* systems near Ballarat further indicate an ancient system of rivers, corresponding approximately to existing drainage courses; the southern corresponding to the Yarrowee, the western to the Burrumbeet, and the eastern to the Moorabool watersheds.

In concluding this brief notice of the Report, we cannot omit Mr. Brough Smyth's pertinent remarks—"The value of a geological survey is not to be measured by any discoveries of minerals which may be made by the surveyors. The primary object is to make known observed facts relating to the structure of the earth's surface, and to place in due order of succession the several rock formations which present themselves to view. All the aspects of each formation should be shown, and here the aid of the palæontologist is indispensable. To prosecute a geological survey with no other object than that of discovering minerals of economic value, is a mean avoidance of the duties which we owe to others who are labouring with different aims in all parts of the globe." J. M.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.

I.—June 10th, 1874.—John Evans, Esq., F.R.S., President, in the Chair.—The following communications were read:—

1. "On the Occurrence of Thanet-beds and of Crag at Sudbury, Suffolk." By William Whitaker, Esq., B.A., F.G.S.

After referring to some passages in papers by Mr. Prestwich, in which the probable existence of Thanet-beds in North Essex is mentioned, the author described certain sections near Balingdon, on the right bank of the Stour, which exhibit sands belonging to this series. The principal section at the Great Chalk-pit, Balingdon, shows, in descending order, beds belonging to the London-clay, Reading-beds 9 feet, and Thanet-sands about 14 feet, resting on Chalk. No fossils occur in the Thanet-beds, and their identification is founded on the uniformity in the character of the sands, their resemblance in fineness, compactness, and colour to the Thanet-sands of West Kent, the presence at the base of the series of a green-sand resembling the "base-bed" of the Thanet-sand, and the occurrence immediately beneath it of a layer of tabular flint, as is usual where the Thanet-sand caps the chalk.

The Crag-beds described by the author are found on the left bank of the Stour, in Suffolk, and consist of ferruginous dark reddish-brown sand, with layers of ironstone, slightly false-bedded, with here and there light-coloured grit with broken shells. In the lower part there are layers of flint-pebbles, phosphatic nodules, and phosphatized bones, which also form a bed about one foot thick at the bottom. These beds rest on deposits belonging to the lower portion of the Thanet-sands, and these again on the Chalk. In one pit a nsiderable number of fossils occur, but not in a condition to enable them to be satisfactorily determined. From its position and general characters these beds were referred by the author to the Red Crag.

DISCUSSION.—Mr. Prestwich said that he was quite prepared to accept Mr. Whitaker's interpretation of the beds referred to the Thanet-sand.

Rev. — Timins remarked that the presence of ironstone did not prove the beds in which it occurs to belong to the Red Crag.

Mr. Gwyn Jeffreys said that the limits of the Red Crag are not easy to determine, and that the casts of the shells obtained in the beds near Sudbury are not sufficient to prove the exact position to which they should be referred.

Mr. Seeley stated that he had seen fine sections of Thanet-sands fully 20 feet thick at Hagley. They contained sharks' teeth. The sands were capped with pebbles, and above these with London-clay. The Woolwich-beds either thin out to the north or are changed to sands at Hagley.

Mr. Charlesworth inquired as to the number of species that could be identified with true Red Crag fossils. He thought that the presence of phosphatic nodules was confirmatory of the beds belonging to either the Red or the Mammaliferous Crag.

Mr. Godwin-Austen remarked that the occurrence of Thanet-sands at Sudbury was a fact of much geological interest.

Prof. Ramsay considered that freshwater conditions generally succeed marine, and that the submergence of the Chalk areas was followed by upheaval of land.

Prof. Hughes thought that the base of the Thanet-sands could not represent a land-surface, but that there had been land in the neighbourhood which gave rise to fluviatile conditions.

Mr. Whitaker, in reply, said that he thought Mr. Seeley was mistaken in asserting the occurrence of Thanet-beds at Hagley. He maintained that the balance of probabilities was in favour of the beds referred by him to the Red Crag being of that age rather than drift.

2. "Notes on the Phenomena of the Quaternary Period in the Isle of Portland and around Weymouth." By Joseph Prestwich, Esq., F.R.S., F.G.S.

The author remarked that although the physical features connected with the later geological changes in this district were of much interest, they had hitherto attracted little attention. Commencing with the oldest drift-beds, he showed that the remains of one, formerly more extensive, had been found in the Isle of Portland at a height of 400 feet above the sea; that it contained the remains of the *Elephas antiquus*, *Equus fossilis*, etc.; and that he found in this bed a number of pebbles of sandstone and ironstone of Tertiary age, and of chert from the Greensands, whence he inferred that, as such pebbles could not now pass over the plain of Weymouth, they must have done so before that area was denuded, and when bridged over by the Portland and Purbeck beds; for the pebbles are derived from beds which are only *in situ* to the north of the Weymouth district, and at a distance of eight to ten miles from Portland. Further, this transport must have taken place before the elevation of the north end of Portland, and when the slope from the Bill to the Ridgeway was uniform and gradual. The anticlinal line, which has elevated the intermediate area, must be of later date than the drift-bed.

The author next proceeded to notice the raised beach at the Bill of Portland, in which he had, with the assistance of Mr. Jeffreys, determined 26 species of shells, two of them not now living in the British Channel, and one new. This beach contains pebbles of the Devonshire and Cornwall rocks.

The raised beach Mr. Prestwich found to abut against an old cliff that had been swamped at a later geological period by a land-wash, which had levelled it and the old sea-land with the adjacent land-surface. The mass which had thus swamped the cliff and buried the beach consisted of loam and angular débris, the latter being in larger proportion at top. In the loam he found several species of land and freshwater shells and fragments of bones. The angular débris consisted of pieces of the local rocks, together with a number of specimens, which by their organic remains were shown to belong to the Middle Purbecks, a part of the series not now existing in Portland. A similar bed, but much thicker, was then described at Chesilton, in the north of the island. It is there 60 feet thick, and contains large blocks of Portland stone and Portland chert, the greater number of which are in the upper part of the deposit, which is here on the sea-level, and 400 feet lower than the Portland escarpment which rises above it. This loam and angular débris the author was disposed to attribute to a temporary submergence of the land to a depth exceeding the height of Portland, and by which the land as it emerged was swept, and its débris carried down to the lowest levels, with the remains of its land-animals and land and freshwater shells, which latter, where protected by large masses of loam and suddenly entombed, have been preserved uninjured. To this deposit, which is common over the raised beaches on the south coast, the author proposed to apply the term "Land-wash."

The paper concluded with a short notice of the drift-beds formed subsequently to the denudation of the Weymouth district, and therefore never on the high-level Portland drift. Amongst these was one near Weymouth of singular character, consisting almost entirely of subangular fragments of Greensand chert, which could not have been derived from beds nearer than Abbotsbury. The lower drift of the district is the valley-gravel of Upway and Radipole, in which the remains of *Elephas primigenius* have been found.

DISCUSSION.—The Rev. O. Fisher remarked that the summit of the Isle of Portland was capped with polished pebbles. Bones of Elephant and of *Bos longifrons*, with a slingstone, were found on a ledge in a fissure at the top of the talus, together with materials from the surface and land-shells. The polished pebbles were produced by water containing mud filtering through them, and passing below into fissures caused by the slipping of the stone on the clay.

Mr. Topley considered that the date of the disturbance described was low down in the Drift period. A part of the drift containing Lower Greensand pebbles may have been caused by an unconformable overlap.

Prof. Hughes thought that the whole question turned upon the original configuration of the country,—what was the line of the old channel in the old river-valley now forming the English Channel?

Prof. Ramsay remarked that many questions were raised by this paper. In the anticlinal of the Weald the Cretaceous strata are accidentally conformable, whilst more to the west the Oolites are unconformable to the Cretaceous. The mass of the Eocene passed over the anticlinals of the Portland district; and what had become of the overlying mass? He thought that it had probably been removed by subaërial influences.

Mr. Koch referred to the polishing of stones in river-beds, which he had noticed in the north of Spain, in Bohemia, and in the Jura, and stated that in the river-beds carbonate of lime is deposited on the stones and preserves their polish.

Mr. Godwin-Austen said that to whatever period the east and west disturbances might be assigned, they were evidently comparatively recent. The phenomena shown in the section described by Mr. Prestwich corresponded with what might be observed in modern beaches. The angular gravels might be due to glacial action.

Mr. Gwyn Jeffreys stated that the first shell-sand obtained from the raised beach was found to contain forms identical with those of the existing beach, but the second collection gave species not found nearer than Scarborough and Dublin. He referred especially to the presence of *Cyprina minuta*—a Greenland form found on the coasts of New England, rare in the south of England, but common in Shetland. He regarded the raised sea-beach as of the same character as those in Scotland containing a northern fauna; the species were essentially northern, and no Mediterranean forms were met with. In the Selsea raised beach the species are of southern forms.

Mr. Prestwich, in reply, stated that the fissures referred to by Mr. Fisher are quite recent, and contain remains of the wild boar. They had nothing to do with the raised beaches. The pebbles he considered to have been transported before the denudation.

3. "On the Character of the Diamantiferous Rock of South Africa." By Prof. N. Story Maskelyne, F.R.S., F.G.S., Keeper, and Dr. Flight, Senior Assistant, of the Mineralogical Department, British Museum.

In this paper the authors confirmed certain statements made by one of them from a superficial examination of specimens brought to this country by Mr. Dunn. The specimens examined and analyzed by Dr. Flight were obtained from various diggings and from different depths, down to 180 feet in the case of one mass from Colesberg Kopje. Their characters throughout are essentially the same.

The rock consists of a soft and somewhat pulverulent ground-mass, composed of a mineral (soapy to the touch) of a light yellowish colour in the upper, and of an olive-green to bluish-grey colour in the lower parts of the excavations. Interspersed in the mass are fragments of more or less altered shale, and a micaceous-looking mineral of the vermiculite group, which sometimes becomes an important constituent of the rock, which also contains bright green crystals of a ferruginous enstatite (bronzite), and sometimes a hornblendic mineral closely resembling smaragdite. A pale buff bronzite occurs in larger fragments than the green form of the mineral; and in the rock of Du Toit's Pan an altered diallage is present. Opaline silica, in the form of hyalite or of hornstone, is disseminated through the greater part of the rock-masses, and they are everywhere penetrated by calcite.

The analyses of the component minerals (given in detail in the paper) show that this once igneous rock is a bronzite rock converted into a hydrated magnesium silicate, having the chemical characters of a hydrated bronzite, except where the remains of crystals have resisted metamorphism. Except in the absence of olivine and the small amount of augitic mineral, it might be compared with the well-known Lehrzolite rock.

The diamonds are said to occur most plentifully, or almost exclusively, in the neighbourhood of dykes of diorite which intersect the hydrated rock, or occur between it and the horizontal strata through which the igneous rocks have been projected. The authors compare the characters of the diamonds found in different positions, and come to the conclusion that their source is not very remote from that in which they are now found.

The mineral above mentioned as resembling vermiculite is described by the authors as a new species under the name of Vaalite.

4. "Note on a modified form of Dinosaurian Ilium, hitherto reputed Scapula, indicative of a new Genus, or possibly of a new Order of Reptiles." By J. W. Hulke, Esq., F.R.S., F.G.S.

The author re-examines Mantell's "Scapula of an unknown Reptile"—Owen's "Scapula of Megalosaurus?", and adduces reasons for considering it to be a modified Dinosaurian ilium. He describes two new examples of the bone in Dr. Wilkins's collection, contrasts them with undoubted scapulæ of sundry Dinosaurs and existing reptiles, and proves their essential correspondence with the ilia of known Dinosaurs.

5. "Note on a Reptilian Tibia and Humerus (probably of *Hylæosaurus*), from the Wealden Formation in the Isle of Wight." By J. W. Hulke, Esq., F.R.S., F.G.S.

In this communication the author describes two saurian limb-bones, remarkable for the great expansion of their articular ends, and the shortness and smallness of their shaft. The features of the tibia are more like those of the tibia of *Hylæosaurus* than of any other Dinosaur. This resemblance, and the suitability of the humerus to the very massive articular end of the Hylæosaurian scapula, dispose the author to refer the bones to this Saurian.

II.—June 24th, 1874.—John Evans, Esq., F.R.S., President, in the Chair. The following communications were read:—

1. "New Carboniferous Polyzoa." By Prof. John Young, M.D., F.G.S., and John Young, Esq., F.G.S., Hunterian Museum, Glasgow University.

The authors described two new forms of Polyzoa from the Carboniferous Limestone shales near Glasgow. For one of these they proposed to form a new genus, *Actinostoma*, allied to *Fenestella*, with the frond erect, and poriferous on one face only, and with the fenestrules oblong. The species they named *A. fenestratum*. The second species was described under the name of *Glauconome stellipora*.

2. "On *Palæocoryne* and other Polyzoal Appendages." By Prof. John Young, M.D., F.G.S., and John Young, Esq., F.G.S., Hunterian Museum, Glasgow University.

The authors maintained that the structures described by MM. Duncan and Jenkins under the name of *Palæocoryne* are not independent organisms, but mere processes of the Polyzoa on which they occur, the cells at the base being only the cells of the Polyzoa. They stated that the tissues of the two structures are perfectly continuous, that the "dactylose basal lobes" are the branches of the Polyzoon of which the processes are continuations, that the stem, capitulum, and branches of the processes are solid, that there is no normal aperture in the capitulum, that the stems do not always bear capitula, even when they give off branches, and that in many cases they are mere processes without either capitulum or branches. According to their observations, the stellate processes called *Palæo-*

coryne are given off chiefly from the poriferous face, and the other processes from the poriferous and non-poriferous faces, and from the edge and base of the frond. The authors did not express any positive opinion as to the function of these processes, but they suggested that those given off from the non-poriferous face and from the base of calycine fronds, may serve as adventitious roots, and those given off from the margins and from the poriferous face near the margins, may be irregularities of growth, unless they are the commencement of new fronds.

Discussion.—Prof. Duncan remarked that it was to be regretted that those critics who differed from original investigators in matters of fact did not correspond with them before offering their views to the Society. Had this course been taken in this instance, he would have been spared the necessity of explaining Prof. and Mr. Young's errors of observation, and of showing that they had not as yet comprehended either the anatomy or the classificatory position of *Palæocoryne*. He objected to Palæozoic Polyzoa being saddled with such "appendages" as *Palæocoryne*, because no modern form had anything like them, for they could not be compared with the avicularia or with vibracula. Moreover the base of *Palæocoryne* sat upon, covered, and destroyed numerous cells of the Polyzoon. It could not therefore be a sterile or any form of appendage, but must be looked upon as parasitic in the sense already explained by him and his colleague Mr. Jenkins. Of course there being no screws or pegs in Palæozoic times, the *Palæocoryne* could only attach itself by a fusion of its hard parts with those of the Polyzoon. Such organic connexion is common enough between modern parasites and their hosts. He had carefully studied the morphology of *Palæocoryne* with Mr. Jenkins, and the drawings had been admirably executed by the artist, and in the course of their investigations such opinions as those expressed by Prof. Young had occurred to them. He was satisfied that the ornamentation of *Palæocoryne* was mimetic of that of the Polyzoon, and that the stems, capitulum, and arms were originally hollow. He exhibited drawings and specimens showing the fistulose condition of the arms (from the collection of the Geological Survey of Scotland). When the structures were perfectly fossilized, they were of course solid, but the original central tube could be distinguished in most instances by the nature of the mineralization. Prof. Young had mistaken pieces of *Fenestella* for *Palæocoryne*, and had not distinguished the stolons of the Polyzoon from the arms of the hydroid.

Mr. Jenkins said that among recent Polyzoa there is only one genus that has an appendage at all similar to *Palæocoryne*. This appendage, however, is very small in comparison with the individual Polyzoon, whilst the base of *Palæocoryne* covers 50 cells of the *Fenestella*. He thought it very unlikely that so large a surface should be sterile or useless.

3. "The Steppes of Siberia." By Thomas Belt, Esq., F.G.S.

The author described the portion of the Siberian steppes traversed by him as consisting of sand and loam. The best section seen by him was at Pavlodar, where he found 1 foot of surface soil, 20 feet of stratified reddish-brown sand, with lines of small gravel, 8 feet of light-coloured sandy silt, 15 feet of coarse sand, with lines of small pebbles, and 1 line of large ones, and 6 feet of clayey unlaminated silt, with fragments of the bed rock in its lower half, the bed rock being Magnesian Limestone much crushed at the top. South of Pavlodar the surface was covered with pebbles, which became larger in advancing southward, until the soil was full of large angular quartz boulders. Further south the bed-rock comes to the surface in ridges and low hills, increasing in height until some of them attain 2000 feet. All the rock-surfaces were much shattered, as if by the action of frost, but they showed no signs of glacier-action. The ridges and hills were separated by plains composed of sandy clay, with numerous angular fragments derived from the rocks in the immediate neighbourhood. This is accounted for by the author on the supposition that they formed a series of shallow lakes, frozen over in winter, and that the ice on breaking up carried away fragments of the rocks. The distribution of the boulders on the plain north of the ridges was also attributed to floating ice.

The generally accepted marine origin of the great plain was said to be negatived by the absence of sea shells in its deposits, whilst *Cyrena fluminalis* occurs in them. The author regards them as deposits from a great expanse of fresh water kept back by a barrier of polar ice descending far towards the south. In its greatest extension this ice-barrier would produce the crushing of the bed-rock; and as it retreated, the water coming down from the higher ground in the south would cover a continually increasing surface.

Discussion.—Mr. Drew thought that the deposits had a lacustrine aspect. Their nearest parallel was to be found in the great plain of India, the origin of which was not quite clear, although it had perhaps originated as a delta. He did not think that the ground had been covered by an ice-cap.

Mr. Hulke believed that the author's view as to the origin of the deposits was correct. He thought that the plains of Hungary were of a similar nature, their freshwater deposits having been formed in consequence of the stoppage of the Danube, changing what had been a dry plain into a vast lake. The effects described by the author might have been produced by a rise of land in the north.

Prof. Ansted remarked that the extent of the country under consideration might be estimated roughly at 3,000,000 square miles, and asked whether this was to be regarded as the area of a freshwater lake. If so, whence did the water come and where did it go? He thought such a phenomenon of very unlikely occurrence.

Mr. Belt, in reply, said that he was glad to find that the marine theory had had no supporters. He maintained as a fact that if a barrier were placed across the country, the numerous rivers would soon flood its whole surface.

4. "On the Microscopic Structure and Composition of British Carboniferous Dolerites." By S. Allport, Esq., F G.S.

The object of this paper is to supply further and conclusive evidence to show that there are dolerites and basalts of Carboniferous age whose original mineral constitution is precisely the same as those of the later Tertiary periods, those of both ages presenting the same varieties of structure, and that the great alterations which most of the older rocks have undergone, constitute the only difference between the two groups. The author describes at some length the various constituents under the following heads, viz. felspar, augite, olivine, magnetite, mica, apatite, glassy matrix, etc. He next describes the occurrence of dolerites in the Midland Coalfields, Ireland, Edinburgh, Arran, etc.

In conclusion he draws attention to the many variations in composition and texture in the same rock-mass, and accounts for them thus:—If the lava were simply in a viscid state, with the ingredients imperfectly mixed, portions of it must, on consolidation, contain them in various proportions, just as is known to be the case in imperfectly fused slags.

He maintains that there is an absolute identity of composition, structure, and mode of occurrence in these eruptive rocks of very widely separated geological periods, and that therefore they should be placed in one group.

5. "Additional Remarks on Boulders, with a particular reference

a group of very large and far-travelled erratics in Llanarmon rish, Denbighshire." By D. Mackintosh, Esq., F.G.S.

The author, after referring to a number of northern-drift boulders addition to those he had noticed in a former paper, describes veral large felspathic boulders found up to a height of about 50 feet above the sea, on Cefn-y-fedw, N. of Llangollen. He en gives a somewhat detailed account of the drifts in the neigh- urhood of Corwen, and of some large felspathic boulders, probably om the Arenig mountains, which are generally found on the sur- ce, or interposed between the lower Boulder-clay and an upland tension of the middle sand of the plains. The main part of the per is devoted to an account of the discovery of a numerous group very large and far-travelled felspathic boulders in the parish of lanarmon. Denbighshire. The author refers particularly to a re- arkable slickensided boulder, and to the great "Immovable Stone" Maendigychwyn (now called Eryrys), about 1150 feet above the a, which is the largest far-transported boulder he has heard of in e British Isles. He stated a number of facts and considerations hich led him to believe that the Llanarmon boulders, along with ose further N. and W., must have come all the way from Snowdon, d that they were floated over passes or cols in the intervening nges of hills by icebergs or coast-ice about the close of the Lower oulder-clay period. He concluded by noticing the necessity for a rsonal examination of boulders, instead of relying on answers to ieries, and stated that about Llanarmon the felspathic boulders are lled "gaanite tumblers," while in Cheshire all kinds of boulders e called "marble stones."

6. "Note on the Bingera Diamond-fields." By Archibald Liver- dge, Esq., F.G.S.

The author commenced by describing the general characters of e older Australian Diamond-field of the Mudgee or Cudgegong istrict. The Bingera Diamond-field is situated in a basin among e mountains of the Drummond Range, the encircling hills being of rboniferous or Devonian age. The diamantiferous drift occurs in tches in the basin, which is invaded by spurs of basalt. The rock der the drift is an argillaceous shale, and here and there are out- ops of a siliceous conglomerate. The diamonds have hitherto en worked only at the surface. The author mentions the principal inerals found associated with the diamonds, which are generally all, and their crystalline forms not very well developed. He also marks on the general accordance in the geological constitution of rious diamantiferous districts.

7. "Remarks on the Working of the Molar Teeth of the *Dipro- lon*." By Gerard Krefft, Esq., F.L.S. Communicated by the resident.

In this paper the author criticized a figure of the lower molars of *iprotodon*, published by Professor Owen, on the ground that the eth are represented in it in an unabraded state, and stated that hen the last tooth breaks through the gum, the first of the series is always worn flat. He also remarked on the peculiar modification of the premolar in the genus *Diprotodon.*

8. "Description of Species of *Chætetes* from the Lower Silurian Rocks of North America." By Prof. H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., F.G.S.

In this paper the author accepted the union of *Chætetes* and *Stenopora* made by Milne-Edwards and Haime, and stated that *Monticulipora*, D'Orb., and *Nebulipora*, McCoy, also seemed to him to belong to the same generic group, for which he proposed to employ the name *Chætetes.* The genus thus defined he proposed to divide into four groups, under which he described the following North-American species:—

Group I. Ramose species:—

C. Dalei, rugosus, pulchellus, and *Fletcheri,* M.-Edw. and Haime; *C. gracilis,* James; and *C. approximatus, attritus, delicatulus, nodulosus, Jamesi,* and *rhombicus,* sp. nov.

Group II. Frondescent and Palmate species:—

C. mammulatus, M.-Edw. and Haime; *frondosus,* D'Orb. (?); and *clathratulus,* James.

Group III. Massive and Discoid species:—

C. petropolitanus, Pand.; and *discoideus,* James; and

Group IV. Encrusting species:—

C. papillatus, McCoy; and *corticans* and *Ortoni,* sp. nov.

Most of the species are from the Cincinnati group near Cincinnati.

9. "On the Composition and Structure of the Bony Palate of *Ctenodus.*" By L. C. Miall, Esq. Communicated by Prof. P. Martin Duncan, F.R.S., F.G.S.

The specimen noticed by the author was obtained from the Low-Main Coal-seam of Newsham, Northumberland. The component bones are a parasphenoid and a pair of pterygo-palatals. The left dental plate agrees with the type of *Ctenodus cristatus,* Agassiz, in the Leeds Museum. The author describes the bones and teeth in detail. He regards *Ctenodus* as closely related to *Ceratodus* in the structure of the palate, and as differing but little from the Devonian *Dipterus.*

10. "Notes on a Railway Section of the Lower Lias and Rhætics between Stratford-on-Avon and Fenny Compton, and on the occurrence of the Rhætics near Kineton and the Insect-beds near Knowle in Warwickshire, and on the recent discovery of the Rhætics near Leicester." By the Rev. P. B. Brodie, M.A., F.G.S.

This paper consists of a detailed description of the strata exposed at a little distance from the railway-station at Stratford-on-Avon and at Kineton, and of the evidence of the existence of the Insect-beds near Knowle in Warwickshire. The author also records the discovery of the Rhætics near Leicester by Mr. Harrison. The following is the section at the brick-pit at the base of the Spinney Hills in ascending order:—twenty feet of red and blue marls, twenty feet of hard fissured sandy marl containing fish-scales, and fifteen feet of black and light-coloured shales full of fossils. The beds appear to dip to the S.E.

11. "The Resemblances of Ichthyosaurian Bones to the Bones of other Animals." By Harry Govier Seeley, Esq., F.L.S., F.G.S.

Hitherto in comparative anatomy the term affinity has been vaguely used in treating of the extinct groups. In this paper the author endeavoured to give precision to the term Ichthyosaurian by analyzing the characters of the Ichthyosaurian skeleton into the resemblances which it presents to the skeletons of other vertebrates. Ichthyosaurian characters are subdivided into Mammalian, Avian, Crocodilian, Chelonian, Lacertilian, Cameleonian, Rhynchocephalian, Ophidian, Urodelan, Piscine, Plesiosaurian, Dinosaurian, Dicynodont, and Labyrinthodont. By thus classifying the characters it is anticipated that the affinities of the Ichthyosaurian type may be rendered evident.

12. "The Resemblances of Plesiosaurian Bones with the Bones of other Animals." By Harry Govier Seeley, Esq., F.L.S., F.G.S.

This paper is an attempt to make a similar analysis of the Plesiosaurian skeleton.

13. "On the Tibia of *Megalornis*, a large Struthious Bird from the London Clay." By Harry Govier Seeley, Esq., F.L.S., F.G.S.

The author described the distal portion of a right tibia of a large struthious bird from the London Clay of Eastchurch in Sheppey. The only living types approximating to it are the Apteryx, which similarly has the shaft at the back of the distal articulation, and the Emu, which similarly has the shaft compressed from back to front. The author considered that the skull named by Prof. Owen *Dasornis* might, if it belonged to a bird, be referred to *Megalornis;* but he detailed considerations which led him to suggest that *Dasornis* may possibly be a fish.

14. "On Cervical and Dorsal Vertebræ of *Crocodilus cantabrigiensis*, Seeley, from the Cambridge Upper Greensand." By Harry Govier Seeley, Esq., F.L.S., F.G.S.

The author described in detail a cervical and a dorsal vertebra of a procœlous Crocodile from the Cambridge Upper Greensand, which in the main presented the character of a young existing Crocodile coupled with distinctive features. The centrum of the cervical vertebra is oblique, and the neural canal of the dorsal vertebra is small as in *Hyposaurus*. The species is of small size.

15. "On the Base of a large Lacertian Skull from the Potton Sands." By Harry Govier Seeley, Esq., F.L.S., F.G.S.

This specimen was interpreted by the author as the anchylosed basioccipital and basisphenoid of a Dinosaur. It showed a resemblance to Crocodiles in its posterior aspect, but in all other respects was Lacertian; it makes a close approximation to *Hatteria*, and in no respect shows affinity to birds. The pterygoid processes look downward, and the basioccipital condyle looks downward and backward. The base of the brain-cavity is long and narrow, while its anterior border corresponds to an imperfectly ossified fibro-cartilage seen in the same position in *Hatteria*. The author did not regard the specimen as giving support to Prof. Huxley's hypothesis of the Avian affinities of Dinosaurs.

16. "A Section through the Devonian Strata of West Somerset." By Harry Govier Seeley, Esq., F.L.S., F.G.S.

In 1867 the author had visited the Devonian country in search of the fault which Mr. Jukes supposed to traverse Devon and West Somerset. He satisfied himself by sectional evidence that no fault existed; and in a section from Hurlstone Point to Brushford has noted down the mineral character of the successive groups of strata forming the country; and the only folds of the strata seen by him on that line of section. He thought that Mr. Etheridge's detailed grouping of the rocks was better suited to the N.W. part of the country than West Somerset, and that for that region the divisions of strata used by Mr. Jukes were convenient.

17. "On the Pectoral Arch and Fore Limb of *Ophthalmosaurus*." By Harry Govier Seeley, Esq., F.L.S., F.G.S.

After some remarks on the structure of the pectoral arch in *Ichthyosaurus*, the author described parts of a skeleton discovered by Mr. Leeds in the Oxford Clay, on which he founded the genus *Ophthalmosaurus*.

The pectoral arch comprised the usual bones, but their relation to each other was unusual. The clavicles form a strong arch; the lateral clavicles join behind by interlacing sutural union, and not by overlap; while in front the episternum (or interclavicle) is wedged in between them so as to divide them. The coracoids are expanded and grasped by the clavicles in a depression in their margins; the scapula is large.

The humerus shows the usual Ichthyosaurian characters, and has three facets at the distal end. To these correspond three bones in the fore arm, the olecranon ossification being two-thirds as large as the radius. The single row of carpal bones includes four elements.

18. "The Glacial Phenomena of the Eden Valley and the Western Part of the Yorkshire Dale District." By J. G. Goodchild, Esq. Communicated by H. W. Bristow, Esq., F.R.S., F.G.S.

This paper is a continuation, in a northward direction, of the investigation of glacial phenomena which formed the matter of a paper lately read before the Society by Mr. Tiddeman, and published in the Society's Journal. It gives a detailed description of the district treated of, the occurrence of ice-scratches, glacial erosion, and glacial drift. The author considers that the phenomena recorded by him could not possibly have been produced by floating ice, and therefore must have been caused by land-ice. In the drift he finds evidence of a flow of ice from the south side of the Scottish Southern uplands, and that the ice which filled the Eden Valley seems to have had two opposite directions, the local ice flowing from the high land of the south, pressing outwards far to the north f the currents which flowed eastwards, the latter currents of ice ng up the Eden Valley, but apparently not having ground down the ridges of the high land at the head of the valley. At the same time the author proves that it must have passed over to the lower levels, and that it undoubtedly deepened many of the valleys which happened to lie in its course. He considers that the Scotch ice could not well have exceeded 2400 or 2500 feet in thickness; and finally arrives at these conclusions:—that angular moraine-like drift of the high ground, the upper and lower tills, the deposits which form the eskers, and the numerous stranded boulders, are the result of the melting of a vast thickness of land-ice, charged throughout with stones and boulders of nearly every kind of rock occurring within the area in which the body of the ice originated.

19. "Geological Observations made on a Visit to the Chaderkul, Thian Shan range." By Dr. F. Stoliczka, F.G.S.

In this paper the author gives an account of the geology of the district traversed by him in his journey from near Kashgar to lake Chaderkul on the Russian frontier, a distance of about 112 miles, his route lying among the southern branches of the Thian Shan range.

Three principal ridges were crossed. The first, or "Artush ridge," consisted of newer Tertiary deposits of bedded clay and sand, mostly of a yellowish-white colour. These "Artush beds" were traced by the author for a distance of 22 miles. The southern slopes of this range were covered with gravel from 10 to 15 feet thick, which passes into a conglomerate with a thickness of about 200 feet.

The second, or "Kokan range," is formed on the southern side of old sedimentary rocks, whilst the northern is occupied by newer Tertiary deposits and basaltic rocks, the former consisting of shales and limestones, in which the author found some fossils, inducing him to refer them to the Trias. These are succeeded by some dark-coloured shales, slates, and sandstones, dipping at a high angle to the north.

On the denuded edges of these the newer Tertiaries rest, consisting of sandstones interstratified with basaltic rocks. These latter increase in thickness till just beyond Kulja an old "somma" is reached, with perpendicular walls rising to a height of 1500 feet above the river. The cone of the volcano has disappeared by subsidence.

The third ridge, "Terek-tagh," consists of old sedimentary rocks, chiefly limestones.

20. "Note upon a recent Discovery of Tin-ore in Tasmania." By Charles Gould, Esq., B.A., F.G.S.

In this paper the author states that the ore has been found in large masses *in situ*, and that the containing rock is lithologically distinct from the ordinary ternary granite which forms the whole of the stanniferous country of Queensland. The discovery was made at Mount Bischoff, in the N.W. portion of Tasmania, but as the district is covered by scrub an exact estimate of the exposed area of stanniferous rock is as yet impossible. It does not appear to exceed a few hundred acres. Large quantities of stream-tin have been already obtained.

21. "Note on the Occurrence of a Labyrinthodont in the Yoredale Rocks of Wensleydale." By L. C. Miall, Esq. Communicated by Prof. Huxley, F.R.S., F.G.S.

The author briefly describes a specimen, discovered by Mr. W. Horne, of Leyburn, in the Lower Carboniferous Rocks there, comprising casts of five bones. Two of these are probably tibiæ. Owing to their fragmentary nature the others cannot be accurately determined. The author considers that these bones belong to an animal of higher rank than any known fish, and thinks that the Lower Coal-measures of Glasgow, with *Loxomma*, may be of earlier date than the Yoredale Rocks.

22. "Geological Notes on the Route traversed by the Yarkund Embassy, from Shahidulla to Yarkund and Kashgar." By Dr. F. Stoliczka, F.G.S.

The author described the rocks observed by him along the course of the Karakash river and through the Sanju pass as chiefly metamorphic, and very highly inclined, until near Yám sedimentary rocks rest unconformably on the schists. These are probably Palæozoic. Later rocks occur near the camp Kiwáz, some resembling the rocks of the Nahún group, and underlain by deposits containing Carboniferous fossils. At Sanju coarse grey calcareous sandstones and chloritic marls of Cretaceous age occur. True Löss occurs in some of the valleys.

23. "The Hæmatite Deposits of Whitehaven and Furness." By J. D. Kendall, Esq., F.G.S.

The deposits of hæmatite occur in the Silurian and Carboniferous rocks, but chiefly in the latter, and nearly all those worked in the two districts are found in the Mountain-limestone. They occur at all levels in the limestone, and generally near faults; their dip is the same as that of the beds in which they lie. Their longest axis almost always corresponds with the magnetic meridian. Their internal nature varies at the two localities. The Whitehaven hæmatite is much more compact than that of Furness. In the latter place it contains fossils from the Carboniferous Limestone.

The author considers the hæmatites to have been deposited by water, coming probably from the Coal-measures, containing bicarbonate of iron. The author believes that they were probably deposited after the Millstone-grit, but before the Permian.

24. "Notes on the Physical Characters and Mineralogy of Newfoundland." By John Milne, Esq., F.G.S.

In this paper the author described in considerable detail the physical characters of the island of Newfoundland with regard to its surface configuration and coast outline, the traces of ice-action displayed in it, and its mineral resources. The details of the latter are given under the heads of the various localities visited by the author.

25. "Notes on the Sinaitic Peninsula and North-western Arabia." *John Milne*, Esq., F.G.S.

In this paper the author described in great detail the geological bservations made by him during a journey, in company with Dr. Beke, in the Sinaitic peninsula.

26. "Giants' Kettles at Christiana." By MM. W. C. Brögger nd H. H. Reusch. Communicated by Prof. Kjerulf, F.M.G.S.

The authors first refer to the popular notices about Giants' kettles, nd describe in detail a number of these pits, which were examined nd emptied near Christiania. They then mention the theories oncerning their origin. From their own facts and reading they onclude that many of these remarkable pits were made at the ottom of "Moulins" during a glacial period, when the locality was overed with ice on the scale of existing ice in Greenland. The ontents of these pits are traced to their parent rocks, which are igher up towards the great valley of Gulbransdal, in which glacial henomena abound. They are inclined to conclude that moraine natter was washed off the glacier-ice from time to time, and left in he pits at last.

The Society then adjourned till the 4th November, 1874.

CORRESPONDENCE.

AMPHICENTRUM IN A NEW HORIZON.

Sir,—While carefully looking over a series of fossil teeth from he Sub-carboniferous Limestone, near Richmond, that had been ying in my cabinet for some time, I discovered two beautiful scales of *Megalichthys*, and an undoubted jaw of *Amphicentrum* nearly perfect. It is principally to the jaw that I desire to direct attention, for I am not aware that any remains of *Amphicentrum* have ever been found in the Limestone itself, though they have been obtained from the shales both above and below it, and are comparatively common in the shales of the Upper Coal-measures. This specimen is larger than the jaws usually found in the more recent formation, being half an inch long and one-eighth of an inch broad at the rticular extremity; it presents two ridges, which are joined for some distance along the anterior portion of the surface of the jaw, but which diverge widely as they proceed backwards; these ridges are denticulated, and the denticles are most distinct on the posterior portion, where they resemble small rounded tubercles. The whole of the exposed surface is very plentifully covered with minute pores, which give it an irregularly granular aspect. I have no hesitation in ascribing this specimen to the same species as that found in the Coal-measures, and named *A. granulosum*, Young. The interest attached to this discovery is increased when we remember that the remains found in the Coal-shales must have belonged to fishes that existed in lakes, rivers, or estuaries, while the fishes that lived during the formation of the Sub-carboniferous Limestone must have roamed in salt water; *Amphicentrum* must, therefore, have lived both in fresh and salt waters, like some modern fishes.

The remainder of the teeth in this collection belong to *Cladodus*, *Cochliodus*, *Helodus*, *Petalodus*, *Pleurodus*, and *Pristodus*, many of which fishes are also found in the Upper Coal-measures, and therefore existed in both waters. W. J. BARKAS, M.R.C.S.E., etc.

PALÆOZOIC STARFISHES.

SIR,—Will you allow me to add another Palæozoic Starfish to your very excellent list given in the January number of the MAGAZINE, and which you have probably overlooked. I refer to the genus *Cribellites*, G. Tate (*C. carbonarius*, G. Tate), Proceedings Berwickshire Nat. Field Club, v. p. 71, obtained from a Sandstone in the Carboniferous Limestone series, near Shilbottle, Alnwick.

EDINBURGH, *August* 10, 1874. R. ETHERIDGE, JUN.

PROTOGINE.

SIR,—In a very recent number of the *Academy* mention is made of a fossil, in the Museum at Turin, of considerable interest: a fragment of protogine containing remains of plants, which are supposed to prove the sedimentary origin of that rock. But may not the so-called Protogine be a sedimentary rock formed of the elements of Protogine, and whose history is similar to that of some of the varieties of the so-called Arkose. and named by some French geologists *granite régénéré* or *recomposé?* Mr. Scrope, in his excellent description of the volcanic district of Central France, speaks of such a rock not easily distinguished from the Granite, of whose elements it is composed, and on which it lies. There is an example of this exposed in a quarry above the village of Royat, near Clermont-Ferrand.

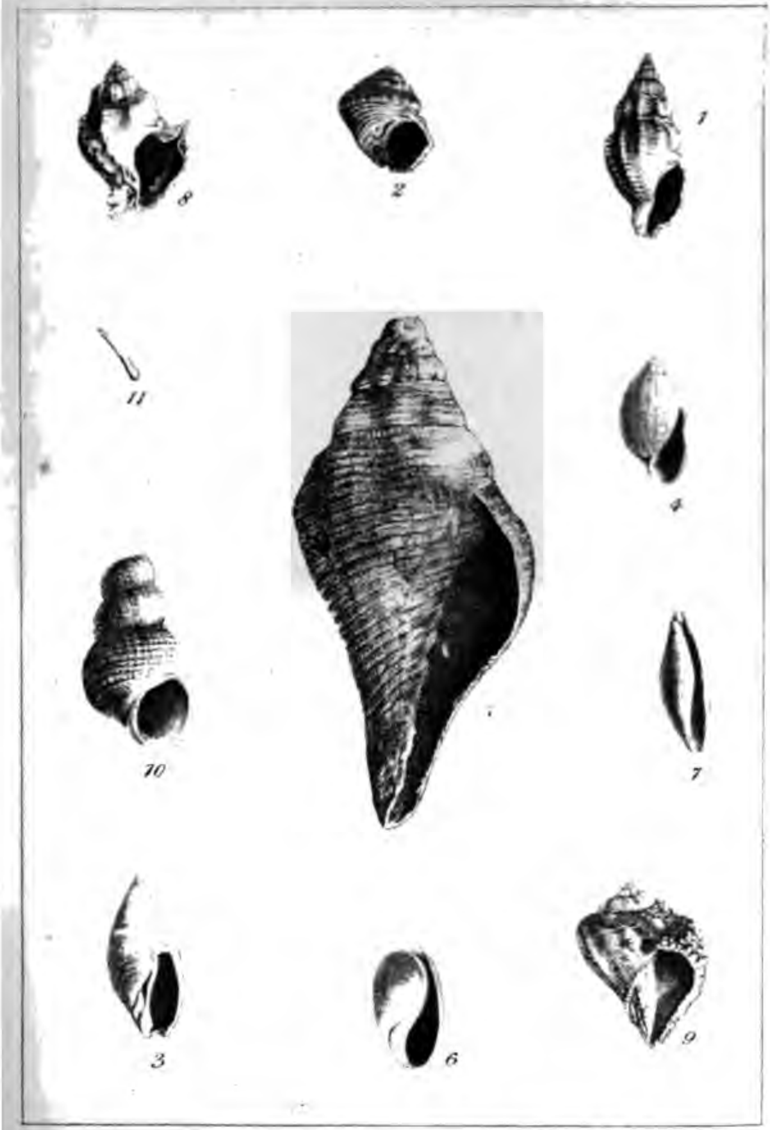
Many granites may well be supposed to have had a sedimentary origin—for the ultimate analysis of certain sedimentary rocks agrees very closely with that of granite—but it is scarcely conceivable that they should still retain any such proof of such an origin as that which this fragment is said to possess. If this should meet the eye of Mr. Scrope, I would venture to ask him whether the fragment referred to may not improbably be supposed to belong to a rock whose origin is similar to that of the reconstituted Granite of the Limagne of Auvergne.

BULTHY HILL, MIDDLETOUN,
WELSHPOOL, *July* 29.
ROBERT GARDNER, JUN.

MISCELLANEOUS.

CAPE TOWN.—On June 30th an earnest effort was made by Mr. Fairbridge, Mr. C. Watermeyer, Mr. Dowling, Mr. Solomon, and other influential members of the House of Assembly, to induce Parliament to appoint a GOVERNMENT GEOLOGIST for the Colony. After an animated discussion, on the motion being put, twenty-three members voted for the appointment, and twenty-four against. A little more pressure next session ought to insure a good majority [illegible] favour of the appointment. Such a rich and important geological [illegible] as the Cape of Good Hope ought no longer to remain red, or only in the hands of amateurs.

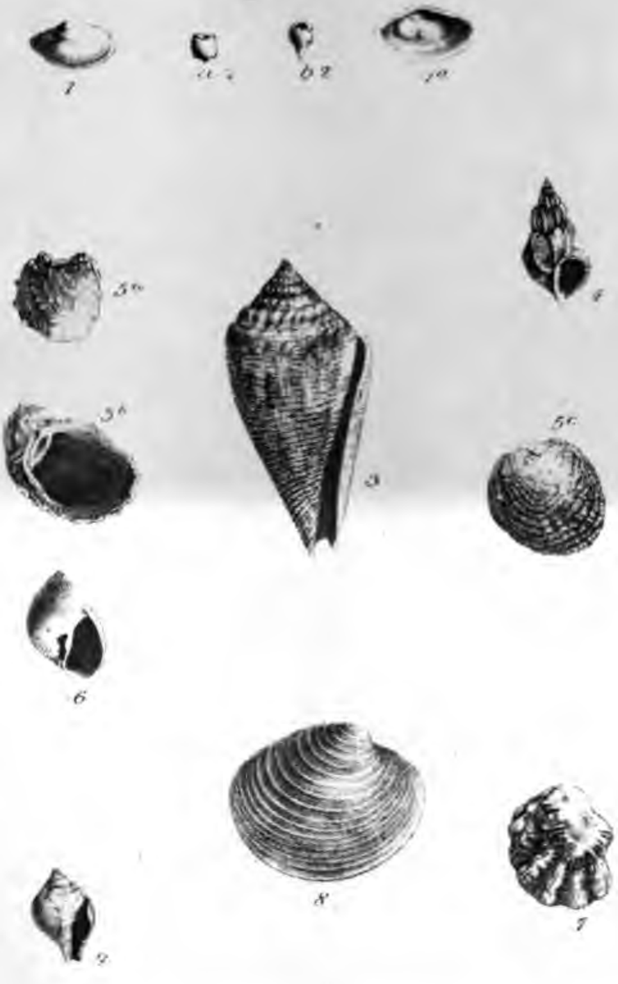
Geol. Mag. 1874. New Series Decade II Vol. I Pl. XVI.



J. Susini, lith.

WESTINDIAN TERTIARY FOSSILS.

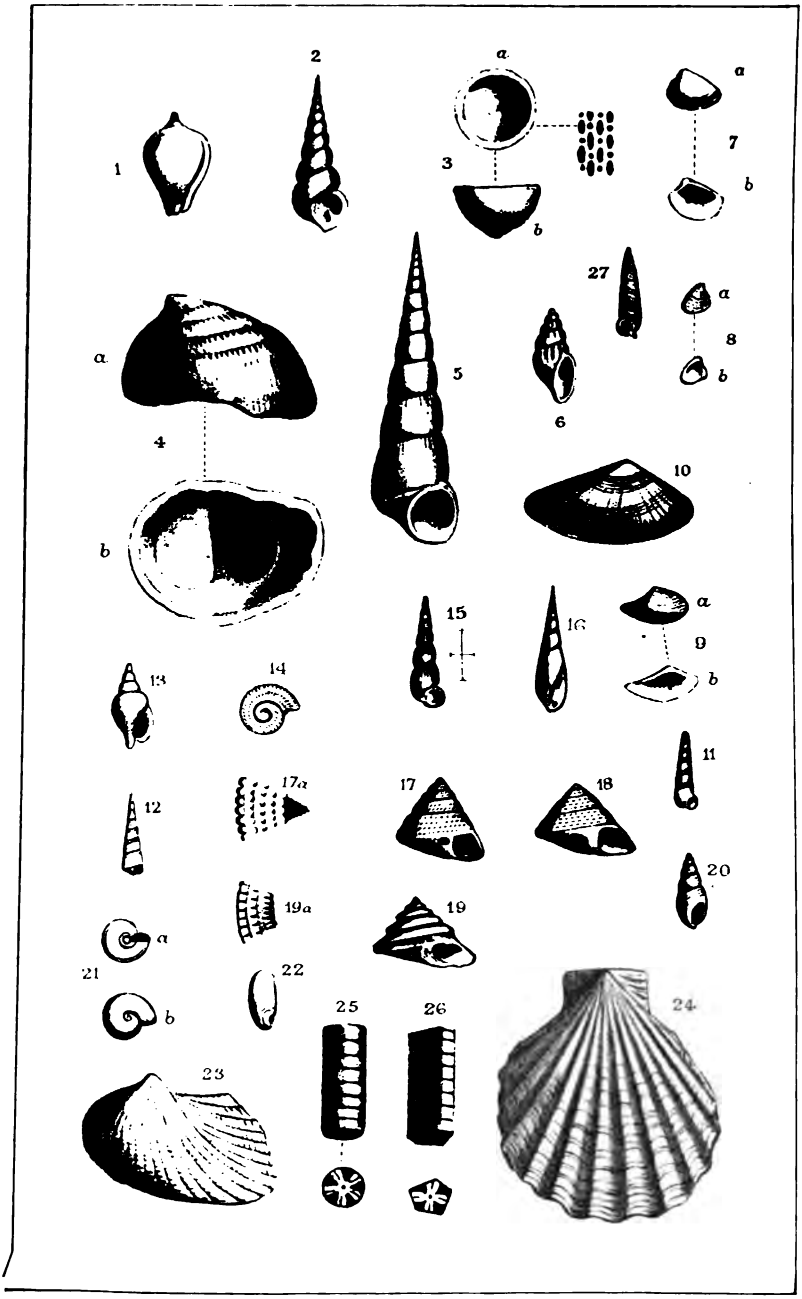
Geol. Mag. 1874. New Series Decade II Vol. I Pl. XVII.



J. Susini lith.

WESTINDIAN TERTIARY FOSSILS.

Geol. Mag. 1874. NEW SERIES. Decade II Vol. I. Pl. XVIII.



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West Indian Tertiary Fossils

THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE II. VOL. I.

No. X.—OCTOBER, 1874.

ORIGINAL ARTICLES.

I.—On the West Indian Tertiary Fossils.

By R. J. Lechmere Guppy, F.L.S., F.G.S., etc.

(PLATES XVI., XVII., and XVIII.[1])

(*Continued from the September Number*, p. 411.)

Strombus pugiloides, n. sp.

The shell for which I propose the above appellation was considered to be *Strombus pugilis* by Mr. Carrick Moore. The name was misprinted *fragilis* in his paper in the Journal of the Geological Society, vol. xix. p. 511. In my papers on the Tertiary fossils of Jamaica and the West Indies, the species was recorded under the name *Str. pugilis*. In ordinary specimens like those usually found in Jamaica, Haiti, and elsewhere, the only well-marked differences that can be noticed between the fossil shell and the recent *Strombus pugilis* are that in the former the last whorl is usually devoid of the spiniform tubercles, and that the shell is of shorter and broader figure. But some examples, supplied me by my friend Mr. Vendryes, exhibit an unexpected character. They show chevron-shaped bands of colour, about 12–15 on the last whorl. Each band takes the shape of a V, the apex of which occurs near the middle of the whorl, and forms an angle of about 30° pointing backwards or away from the aperture. These bands of colour are about two mm. wide and the spaces between them are about three mm. Numerous specimens of the recent *Str. pugilis* have passed through my hands, but I have never noticed the slightest approach to such a character. The recent shell is pale red or pink only relieved by an indistinct band of paler tint following the middle of the whorl. A less constant difference may be found in the low rounded lamellar dentition inside the outer lip which is very faint or altogether wanting in *Strombus pugilis*, but more marked in the fossil.

Murex collatus, n. sp., Pl. XVI. Fig. 8.

Ovate, rimate, slightly flattened, adorned with numerous thin slightly fimbriate or crenulate varices often doubled, especially the later ones; about seven on the last whorl; their interstices indistinctly crossed by low transverse costæ which terminate in points on the varices; the upper point large, acute and projecting, giving an angulate appearance to the shell: varices uniting below to form an irregular and contorted canal. Whorls 6-7, somewhat angulate. Spire sharp. Outer lip expanded and crenulate, obtusely dentate within. Pillar-lip smooth. Length about 25 mm. Breadth about 15. Total length of last whorl, including canal, about 18 mm.

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[1] Plates XVI. and XVII. having been unfortunately lost *in transitu* from Trinidad, they are now being re-drawn and will appear in the November Number.—Edit. Geol. Mag.

Very closely related to *M. calcitrapa*, Lam. (Eocene, Europe). It is smoother and the whorls less angulate. These shells belong to a small group of Murices which exhibits the connexion through *Trophon*, *Rapana*, *Latiaxis*, etc., to *Purpura*. *M. collatus* would perhaps be ranked by some conchologists as a *Trophon*, as has already been done with *M. calcitrapa*.

Typhis alatus, Sowerby.

Journ. Geol. Soc. 1850, vol. vi. p. 48, pl. x. f. 4.

A species almost as near to *T. tubifer* (Eocene, Europe) as *Murex collatus* is to *M. calcitrapa*. The living analogues of *T. alatus* are *T. pinnatus* and *T. Sowerbyi*.

Ancillaria pinguis, n. sp., Pl. XVI. Fig. 3.

Ovate conic, spire elevated, acuminate. Suture usually visible through the enamel which covers the spire, and accompanied at a little distance by a keel, the ridge of which is threadlike. Aperture suboval, elongate. Umbilicus deep, narrow, partly hidden by the callosity of the inner lip. Columella callus strongly twisted. Central portion of last whorl without enamel.

Bears some resemblance to *Anc. lamellata*, Guppy. A near relation is perhaps *A. rubiginosa*, which has a spire of similar character.

Cassis reclusa, n. sp.

Ovate, ventricose, sulcated by about 18 narrow and shallow equidistant spiral grooves, the flattened intervening ridges being raised into knobs by somewhat obscure longitudinal costæ. Spire conic, cancellated. Apex smooth, blunt. Columella expanded into a granose callus; canal short; outer margin thickened and reflected, dentate.

Very closely related to *C. subulosa* (a Bordeaux fossil). It is chiefly to be distinguished by its larger spire and apex, generally narrower and less ventricose figure, and somewhat stouter ornamentation. Amongst recent West Indian species the nearest relation of *C. reclusa* is *C. granulata* (?=*cicatricosa*, Meusch).

Crepitacella cepula, Guppy.

Melanopsis cepula, Journ. Geol. Soc. 1866, vol. xxii. p. 580, pl. xxvi. f. 14.

Crepitacella cepula, Geol. Mag. Vol. IV. (1867), p. 500.

This shell is related to *Cyllene pulchella*, Adams. It is not impossible that some other fossils described as *Melanopsis* really belong to the group *Crepitacella*.

Monodonta basilea, n. sp., Pl. XVI. Fig. 2.

Top-shaped, umbilicate. Apex smooth, sharp. Whorls about seven, very strongly carinate, the stout keel on the angular ridge bearing a row of rounded undulate tubercles, and having near the suture a less distinctly marked keel, between which and the keel on the angle [illegible] is a slight concavity, marked only by faint spiral ridges crossed [illegible]es of growth. Lower half of last whorl forming the base

covered with strong spiral ridges. Mouth subcircular. Columella lip callous, produced into a broad tooth above a short broad rather effuse canal. Outer lip dentate, grooved within. Total length about 15, greatest breadth about 12 millimetres.

In general characters there is some resemblance between this shell and *Trochus cypris*, Orb. (=*Monodonta elegans*, Bast.).

Trochus decipiens, Pl. XVIII. Fig. 18.

Top-shaped, imperforate, ornamented by many spiral lines of moniliform granules; whorls rather concave above, and bearing a rather broad angular keel on their lower portion; base flattened, covered with lines of rather square granules, aperture subquadrate, wider than high, broadly angulate by the keel; columella thickened, spreading into a callus over the umbilicus.

Var. *laticarinatus*, Pl. XVIII. Fig. 19.

Keel broader and higher, whorls deeply concave above, suture deeply impressed; lines on the base squamosely granular.

Pliocene, Trinidad.

Trochus plicomphalus, Pl. XVIII. Fig. 17.

Top-shaped, deeply perforated by a small circular umbilicus, zoned with many spiral granular lines, aperture subquadrate, columella straight, thickened; base with many (10–20) moniliform rows of granules, umbilicus deep, its margins dentate.

Pliocene, Trinidad. It resembles *T. ziziphinus* in shape, but is devoid of any keel on the whorls.

Vitrinella marginata, Pl. XVIII. Fig. 21.

Orbicular, umbilicate, discoidal, few-whorled, minutely spirally striate; outer margin with about four small articulated keels not visible from above, the outer one forming the periphery; whorls somewhat convex above; spire raised, ornamented with articulated radiating striæ; aperture nearly circular, rather oblique.

Pliocene, Trinidad. A most elegant little shell.

Crucibulum piliferum.

Shell covered with numerous erect tabular spines which are small towards the apex, larger towards the base; apex small, smooth, spirally recurved.

Pliocene, Trinidad. It may be a variety of the next species, but its plicæ are smaller, whilst the spines furnish an easily-recognized character.

Crucibulum subsutum, Pl. XVIII. Fig. 4.

Strongly striate, rugose, somewhat irregularly oval; striations with a tendency to run in pairs.

Pliocene, Trinidad.

Donax fabagelloides, Pl. XVIII. Fig. 10.

Transversely oblong, somewhat triangular, subequilateral, anterior and posterior angles rounded; zoned with broad dark bands, and finely radiately striate; margins minutely denticulate.

Pliocene: Trinidad. Remarkable for its resemblance to D. fragilis. It is more equilateral than that species, and not so high relatively to its length.

Venus [illegible], n. sp., Pl. XVII. Fig. 8.

Suborbicular, subequilateral, moderately convex, adorned with numerous equidistant concentric lamellæ, between each of which there are about seven or eight concentric striæ; somewhat angulate in front and subarcuate behind; margins crenate. Lunule small, impressed. Posterior dorsal area not defined, striate continuously with the lamellæ of the disk. Umbones small. Cardinal teeth two under the umbo; lateral tooth one, nearly halfway down the posterior slope.

Referred to hitherto in papers on West Indian fossils as *Venus rugosa*, var., to young specimens of which species it bears a somewhat close resemblance. The Jamaican examples are smaller than those from Haiti. A specimen in the British Museum from the latter place is labelled *V. circinaria*, but it is not *Cytherea circinata*, nor even nearly allied to it.

When describing *Cytherea juncea* from Cumana, I omitted to point out the close kinship between that fossil and *C. circinata*.

Chama involuta, n. sp., Pl. XVII. Fig. 5.

Left (attached) valve deep internally, very convex externally, often spiral, completing a turn and a half, covered externally with distant large foliaceous scales more or less erect, between which are small irregular diverging granose ridges. Right valve patulous, ornamented with numerous close concentric sinuous foliaceous laminæ. Umbones large, prominent, spiral. Margin and laminar cardinal tooth crenate.

Mr. Vendryes suggested that this might be a *Diceras*; but I see no ground for referring it to that genus. It is certainly a very spiral *Chama*; but otherwise its characters are in all respects those of the genus. It is apparently always attached by the umbo of the left valve, and the place of attachment is generally marked by the remains or impressions of the septa of corals. It has some resemblance to a recent species found in the West Indies, which, if I have identified it correctly, is *Ch. ruderalis*, Lam.; but besides other considerable differences, the latter is always attached by its right valve.

Plicatula vexillata, n. sp., Pl. XVII. Fig. 7.

Inequivalve, irregularly fanshaped; valves, usually with the disk almost smooth, adorned towards the margin by seven or eight stout obtuse radiating ribs, along each of which are disposed a few lines of reddish brown (probably red when alive), and between which are some distant almost foliaceous concentric striæ of growth. Longest diameter about 17 mill.

Very near to P. ramosa, Lam. Florida.

LIST OF THE FOSSIL MOLLUSCA, ARTICULATA, ECHINODERMATA, AND PROTOZOA HITHERTO DISCOVERED AND RECORDED FROM THE TERTIARY ROCKS OF THE CARIBEAN AREA (EXCLUSIVE OF THE POST-PLIOCENE).

			MIOCENE.						EOCENE.		
SUB-KINGDOM MOLLUSCA. CLASS GASTEROPODA.	Recent.	Pliocene Trinidad.	Cumana.	Barbuda.	Trinidad (Caroni Series).	Jamaica.	Haiti.	Anguilla.	Trinidad (Manzanilla).	Trinidad (San Fernando).	Additional Tertiary Localities.
Physa, Draparnaud.											
rivalis, Mat. & Rack.	x	x									
Planorbis, Geoffroy.											
tervierianus, Orb.	x	x									
Gundlachia, Pfeiff.											
ancyliformis, Pf.	x	x									
Bulla, Klein.											
striata, Brug.	x	x	x	x		x	x				Europe.
Vendryesiana, Guppy						x					
paupercula, Sow.......							x				
granosa, Sow.							x				
Tornatina, Adams.											
coixlacryma, Guppy						x					
canaliculata, Orb. ...	x	x									
Tornatella, Lamarck.											
textilis, Guppy						x					
Cylichna, Lovén.											
ovumlacerti, Guppy ...									x		
Scalaria, Lamarck.											
clathrus, Lam.	x	x									
Leroyi, Guppy					x	x					
Ehrenbergi, Forbes ...											Barbados.
Turbonilla, Risso.											
turris, Orb.	x	x									
subcarinata, Orb. ...	x	x									
Leiostraca, Adams.											
clavata, Guppy		x									
Odostomia, Fleming.											
lævigata, Orb.	x	x									
cancellata, Orb.	x	x									
Aclis, Lovén.											
helecteroides, Guppy ...		x									
Natica, Adanson.											
canrena, Linn.	x	x									
sulcata, Born	x		x			x	x				Panama.
phasianelloides, Orb.						x	x	x		x	Cuba.
subclausa, Sow.						x	x				Panama.
Naticina, Gray.											
regia, Guppy						x					
Sigaretus, Lamarck.											
depressus, Phil.........	x	x									
Ringicula, Deshayes											
tridentata, Guppy ...						x					
Turritella, Lamarck.											
imbricata, Linn.	x	x									
tornata, Guppy			x			x	x		x		
planigyrata, Guppy...					x						
Vermetus, Adanson.											
papulosus, Guppy......						x	x				
lumbricalis, Linn. ...	x	x									
trilineatus, Guppy ...		x									

SUB-KINGDOM MOLLUSCA. CLASS GASTEROPODA.	Recent.	Pliocene Trinidad.	MIOCENE.						EOCENE.		Additional Tertiary Localities.
			Cumana.	Barbuda.	Trinidad (Caroni Series).	Jamaica.	Haiti.	Anguilla.	Trinidad (Manzanilla).	Trinidad (San Fernando).	
Pleurotoma, Lam.											
consors, Sow.						x	x				
venustum, Sow.						x	x				
Barretti, Guppy			x			x	x				
Jamaicense, Guppy ...						x					
Henekeni, Sow.						x	x				
Haitense, Sow.			x			x	x				
Jaquense, Sow.........							x				
elatior, Orb.	x	x									
luctuosa, Orb.	x	x									
Conus, Linné.											
recognitus, Guppy ...						x	x				
planiliratus, Sow. ...					x	x	x				
stenostomus, Sow.......						x	x				
granozonatus, Guppy						x	x				
interstinctus, Guppy...						x	x				
gracilissimus, Guppy			x			x	x		x		
Haitensis, Sow.........							x				
symmetricus, Sow. ...			x				x				
marginatus, Sow. ...							x		x		
Domingensis, Sow. ...							x				
catenatus, Sow.							x				
consobrinus, Sow. ...						x	x				
prototypus, Guppy ...					x						
pusio, Brug.	x	x									
Mangelia, Leach.											
micropleura, Guppy...		x									
Mitra, Lamarck.											
Henekeni, Sow.					x	x	x				
varicosa, Sow.							x				
Voluta, Linné.											
soror, Sow.							x				
pulchella, Sow..........							x				
Ovulum, Bruguières.											
immunitum, Guppy...						x					
Marginella, Lamarck.											
coniformis, Sow.			x		x	x	x				
interrupta, Lam.	x		x								
cœrulescens, Lam.......	x	x									
Volvarina, Hinds.											
pallida, Lam.	x	x									
catenata, Montf.	x	x									
Erato, Risso.											
maugeræ, Gray	x	x									
Cypræa, Linné.											
pustulata, Lam.	x						x				
Henekeni, Sow.........							x				
Dentalium, Linné.											
Mississipense, Conr....							x				U. Stat
dissimile, Guppy						x					
disparile, Orb.	x	x									
Antillarum, Orb.......	x	x									
Trochita, Schumacher.											
rb	x	x									

			Miocene.						Eocene.		
SUB-KINGDOM MOLLUSCA. CLASS GASTEROPODA.	Recent.	Pliocene Trinidad.	Cumana.	Barbuda.	Trinidad (Caroni Series.)	Jamaica.	Haiti.	Anguilla.	Trinidad (Manzanilla).	Trinidad (San Fernando).	Additional Tertiary Localities.
***Crucibulum*, Schum.**											
piliferum, Guppy......		x									
subsutum, Guppy......		x									
Crepidula, Lamarck ...											
aculeata, Lam....... ..	x	x									
Gadinia, Gray.											
afra, Gray...............	x	x									
Fissurella, Lamarck.											
Cayennensis, Lam. ...	x	x									
***Stomatia*, Browne.**											
***eidolon*, Guppy.........**										x	
***Neritina*, Lamarck.**											
Woodwardi, Guppy...						x					
Trochus, Linné.											
decipiens, Guppy		x				x					
plicomphalus, Guppy		x									
Turbo, Linné.											
castaneus, Chemn......	x		x			x					
***Cyclostrema*, Marryat.**											
bicarinatum, Guppy						x					
Vitrinella, Adams.											
marginata, Guppy ...		x									
CLASS PTEROPODA.											
Hyalæa, Lamarck.											
Vendryesiana, Guppy						x					
CLASS CONCHIFERA.											
***Martesia*, Leach.**											
***striata*, Linn. ....**	x	x									
***Teredo*, Linné.**											
***fistula*, Lea ....**					x		x				
Gastrochæna, Spengler.											
cuneiformis, Lam. ...	x	x									
Corbula, Bruguières.											
viminea, Guppy						x	x				
vieta, Guppy...........		x			x	x	x		x		
Cubaniana, Orb.......	x	x									
Caribea, Orb...........	x	x									
Neæra, Gray.											
costellata, Desh.	x					x					
Cercomya, Agassiz.											
ledæformis, Guppy ...									x		
Mactra, Linné.											
turgida, Gmel.........	x	x									
subovalina, Guppy ...										x	
Mactrinula, Gray.											
macescens, Guppy ...									x		
Tellina, Linné.											
biplicata, Conr.				x	x		x				Cuba; U.S.
Strigilla, Turton.											
carnaria, Linn.	x	x									
Semele, Schumacher.											
variegata, Lam.	x	x									

SUB-KINGDOM MOLLUSCA. CLASS CONCHIFERA.	Recent.	Pliocene Trinidad.	MIOCENE.						EOCENE.		Additional Tertiary Localities.
			Cumana.	Barbuda.	Trinidad (Caroni Series).	Jamaica.	Haiti.	Anguilla.	Trinidad (Manzanilla).	Trinidad (San Fernando).	
Donax, Linné.											
striata, Linn.	x	x									
fabagelloides, Guppy		x									
Lucina, Bruguières.											
tigrina, Linn.	x		x				x				[Europe Egypt; Piedmont; [U.States
Pennsylvanica, Linn.	x		x			x	x				
muricata, Chemn.	x	x									
Crassinella, Guppy											
Martinicensis, Orb.	x	x									
Trigona, Megerle											
mactroides, Born.	x	x									
Cytherea, Lamarck.											
planivieta, Guppy.						x					
carbasea, Guppy						x					
juncea, Guppy			x								
convexa, Say	x		x								
circinata, Born.	x	x									
Venus, Linné.											
Blandiana, Guppy						x					
paphia, Linn.	x		x			x	x				Vienna.
rugosa, Chemn.	x					x	x				
puerpera, Linn.	x						x				
flexuosa, Linn.	x	x									
cancellata, Gron.	x	x	x				x				
crenulata, Chemn.	x	x									
Walli, Guppy									x		
Woodwardi, Guppy			x			x					
Dosinia, Scopoli											
acetabulum, Conr.	x				x						U. States.
cyclica, Guppy									x		
Cardium, Linné.											
muricatum, L.	x	x									
Haitense, Sow.	x	x	x			x	x				
lingualeonis, Guppy						x					
inconspicuum, Guppy						x					
castum, Guppy									x		
Cardita, Bruguières.											
minima, Sow.	x	x									
scabricostata, Guppy						x	x				
Chama, Bruguières.											
arcinella, Lam.	x					x	x				U. States.
involuta, Guppy						x					
ruderalis, Lam.	x	x									
Erycina, Lamarck.											
tensa, Guppy									x		
Leda, Schumacher											
bisulcata, Guppy						x					
incognita, Guppy										x	
clara, Guppy						x					
Packeri, Forbes											Barbadoes.
perlepida, Guppy		x									
illecta, Guppy									x		
Nucula, Lamarck											
Schomburgki, Forbes.										x	Barbadoes.

			Miocene.						Eocene.		
Sub-kingdom. MOLLUSCA. Class CONCHIFERA.	Recent.	Pliocene Trinidad.	Cumana.	Barbuda.	Trinidad (Caroni Series).	Jamaica.	Haiti.	Anguilla.	Trinidad (Manzanilla).	Trinidad (San Fernando).	Additional Tertiary Localities.
N. baccata, Guppy		x									
vieta, Guppy............		x									
Arca, Linné.											
occidentalis, Phil.	x	x				x	x				
incongrua, Say.........	x		x								
consobrina, Sow.			x			x	x				
inequilateralis, Guppy						x					
patricia, Sow.					x		x				
trinitaria, Guppy......											
filicata, Guppy.........									x		
centrota, Guppy	x	x							x		
Adamsi, Shuttl.........	x	x									
squamosa, Lam.	x	x									
pexata, Say	x	x	x				x				U. States.
Pectunculus, Lamarck.											
decussatus, Linn.......	x		x			x					
acuticostatus, Sow. ...			x			x	x				
Pecten, Bruguières.											
exasperatus, Sow.......	x					x					
inæqualis, Sow.						x	x				
thetidis, Sow.							x				
nucleus, Born	x	x									
oxygonus, Sow.							x				
comparilis, Tuomey ...					x						U. States.
Anguillensis, Guppy..								x			
Mortoni, Ravenel......								x			U. States.
Plicatula, Lamarck.											
vexillata, Guppy						x					
Spondylus, Lamarck											
bostrychites, Guppy ...						x	x	x			
Ostrea, Linné.											[U. States.
virginica, Gmel.	x				x		x	x			Europe ;
cucullata, Born.	x	x									
Gryphæa, Lamarck.											
athyroides, Guppy ...										x	
Class BRACHIOPODA.											
Terebratula, Lhwyd.											
lecta, Guppy										x	
trinitatensis, Guppy...										x	
carneoides, Guppy ...										x	St. Barts.
Argiope, Deslongch.											
Clevei, Davidson											St. Barts.
Class POLYZOA.											
Cupularia, Orbigny.											
pyriforme	x	x	x			x	x				
calyxglandis, Guppy..									x		
Cellaria, Lamarck.											
salicornia, Pallas. ...	x	x									
Sub-kingdom ARTICULATA.											
Ranina, Lamarck.											
porifera, Woodward..										x	St. Barts.

			MIOCENE.						EOCENE.		
	Recent.	Pliocene Trinidad.	Cumana.	Barbuda.	Trinidad (Caroni Series).	Jamaica.	Haiti.	Anguilla.	Trinidad (Manzanilla).	Trinidad (San Fernando).	Additional Tertiary Localities.
SUB-KINGDOM ARTICULATA.											
Spirorbis, Lamarck											
clymenioides, Guppy..										x	
Ditrupa, Berkeley.											
dentalina, Guppy......						x					
SUB-KINGDOM ECHINODERMATA.											
Cidaris, Lamarck.											
melitensis, Wright ...								x			Europe.
metularia, Lam.	x										Guadeloupe
Tripneustes, Agassiz											
ventricosus, Ag.	x										Ditto.
Echinus, Linné.											
cameleo, Mich.	x										Ditto.
Echinometra, Klein.											
lobata, Blainv.	x										Ditto.
acufera, Blainv.	x							x			
Clypeaster, Lamarck.											
Duchassaingi, Mich...											Ditto.
parvus, Duch.											Ditto.
crustulum, Mich.......											Ditto.
ellipticus, Mich.								x			Ditto.
Scutella, Lamarck.											
Michelini, Duch.											Ditto.
Encope, Agassiz.											
Desmoulinsi, Duch....	x										Ditto.
Echinoneus, Phelsum.											
cyclostomus, Leske ...	x							x			Antilles.
orbicularis, Desor. ...											Cuba.
Caratomus, Agassiz.											
pisiformis, M. & D.											Guadeloupe
Cassidulus, Lamarck.											
Guadelupensis, M. & D.											Ditto.
Echinolampas, Gray.											
semiorbis, Guppy								x			
lycopersicus, Guppy ...								x			
ovumserpentis, Guppy										x	St. Barts.
Pygorhynchus, Agassiz											
Jamaicensis, Mich. ...						x					
Amblypygus, Agassiz.											
Americanus, Mich. ...						x					
Hemiaster, Desor.											[Guadeloupe
Michelottii, Mich.......											Cuba ;
Schizaster, Agassiz											
Cubensis, Orb.											Ditto, do.
Scillæ, Desm.								x			Europe.
Brissus, Klein.											
dimidiatus, Agassiz ...	x							x			Cuba.
Pentacrinus, Miller.											
rotularis, Guppy.......										x	
obtusus, Guppy.........										x	
INCERTÆ SEDIS.											
Cisseis, Guppy.											
asterisca, Guppy										x	

SUB-KINGDOM PROTOZOA. CLASS RHIZOPODA.	MIOCENE.					EOCENE.	
	Cumana.	Antigua.	Jamaica.	Haiti.	Anguilla.	Trinidad.	
Nummulina Ramondi	x	x	x	x	x	x	
Orbitoides Mantelli	x	x	x	x	x	x	
,, *dispansus*		x	x				
,, *media*			x				
,, *papyracea*			x				
,, *Forbesi*			x				
Orbitolites complanatum					x		
Amphistegina vulgaris			x			x	
Heterostegina depressa			x				
Operculina complanata			x				
Miliola seminulum					x		
Robulina cultrata				x			
Rosalina Beccarii				x			
Orbulina universa						x	
Globigerina bulloides			x			x	
Nodosaria glabra						x	
,, *hispida*						x	
,, *raphanus*			x				
,, *raphanistrum*			x	x		x	
,, *ovicula*						x	
,, *pyrula*						x	
,, *affinis*				x			
Spiroloculina nitida						x	
Glandulina lævigata						x	
Dentalina elegans						x	
,, *filiformis*						x	
,, *communis*						x	
,, *acicula*			x				
Polymorphina gibba						x	
Orbitolina vesicularis			x				
Rotalia orbicularis						x	
,, *corallinarum*						x	
Vaginulina striata			x				
,, *legumen*			x				
Frondicularia complanata			x				
Textularia Barretti			x				
Bulimina ovata			x				
Lituola Soldanii			x				
Vertebralina striata			x				
Cuneolina pavonia			x				
Cristellaria calcar			x				
,, *cultrata*			x				
,, *rotulata*			x				
,, *Italica*			x				

EXPLANATION OF PLATES.

ALL THE FIGURES ARE OF THE NATURAL SIZE.

PLATE XVI.

FIG 1. *Phos erectus.*
,, 2. *Monodonta basilea.*
,, 3. *Ancillaria pinguis.*
,, 4. *Tornatella textilis.*
,, 5. *Fasciolaria textilis*
,, 6. *Bulla Vendryesiana.*
FIG. 7. *Ovulum immunitum.*
,, 8. *Murex collatus.*
,, 9. *Purpura Miocenica.*
,, 10. *Scalaria Leroyi.*
,, 11. *Ditrupa dentalina.*

PLATE XVII.

FIG. 1, 1*a*. *Leda clara.*
,, 2*a*, 2*b*. *Hyalæa Vendryesiana.*
,, 3. *Conus consobrinus.*
,, 4. *Cancellaria scalatella.*
,, 5*a*, *b*, *c*. *Chama involuta.*
  5*a*. *exterior of left valve.*
  5*b*. *interior of left valve.*
  5*c*. *exterior of right valve.*
FIG. 6. *Naticina regia.*
,, 7. *Plicatula vexillata.*
,, 8. *Venus Blandiana.*
,, 9. *Conus protatypus.*

PLATE XVIII.

FIG.	1.	*Conus prototypus*	Miocene,	Trinidad.
,,	2.	*Scalaria Leroyi*	,,	,,
,,	3.	*Cupularia calyxglandis*	Eocene	Trinidad.
,,	4.	*Crucibulum subsutum*	Pliocene,	,,
,,	5.	*Turritella planigyrata*	Miocene,	,,
,,	6.	*Mangelia micropleura*	Pliocene,	,,
,,	7.	*Nucula baccata*	,,	,,
,,	8.	——— *victa*	,,	,,
,,	9.	*Leda perlepida*	,,	,,
,,	10.	*Donax fabagelloides*	,,	,,
,,	11.	*Aclis helecteroides*	,,	,,
,,	12.	*Vermetus trilineatus*	,,	,,
,,	13.	*Planaxis crassilabrum*	,,	,,
,,	14.	*Solarium semidecussatum*	,,	,,
,,	15.	*Turbonilla turris*	,,	,,
,,	16.	*Leiostraca clavata*	,,	,,
,,	17.	*Trochus plicomphalus*	,,	,,
,,	18.	——— *decipiens*	,,	,,
,,	19.	——— ——— var. *laticarinatus*	,,	,,
,,	20.	*Columbella peculiaris*	,,	,,
,,	21.	*Vitrinella marginata*	,,	,,
,,	22.	*Cylichna ovumlacerti*	Eocene,	,,
,,	23.	*Arca centrota*	Pliocene,	,,
,,	24.	*Pecten Anguillensis*	Miocene,	Auguilla.
,,	25.	*Pentacrinus rotularis*	Eocene,	Trinidad.
,,	26.	———— *obtusus*	,,	,,
,,	27.	*Triforis guttata*	Pliocene,	,,

II.—NOTES ON THE IMPRESSION OF *PALÆONTINA OOLITICA* IN THE JERMYN STREET MUSEUM.

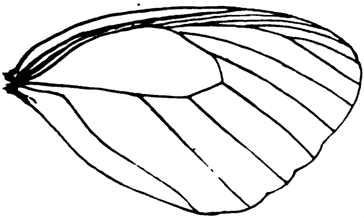
By A. G. BUTLER, F.L.S., F.Z.S., etc.
of the British Museum.

(PLATE XIX.)

IT will be remembered that, in the GEOLOGICAL MAGAZINE for 1873, Vol. X. p. 2, Pl. I. Figs. 1, 2, I described a fossil Butterfly from the Stonesfield Slate under the name of *Palæontina oolitica;* the type was in the possession of Mr. E. Charlesworth, who subsequently discovered that the twin impression had been obtained by Mr. J. W. Judd, F.G.S., who presented it to the Museum of Practical Geology, Jermyn Street.

Soon after the publication of my paper, my friend Mr. Samuel Scudder, of Boston, U.S. (who has long taken great interest in fossil insects, especially *Lepidoptera*), wrote me a letter, from which I subjoin an extract:—

"While in England, I studied the original of your fossil butterfly, and also of its *reverse* in the Museum of the School of Mines. I



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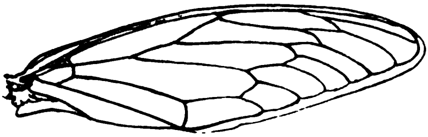

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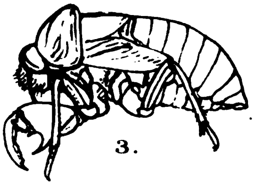

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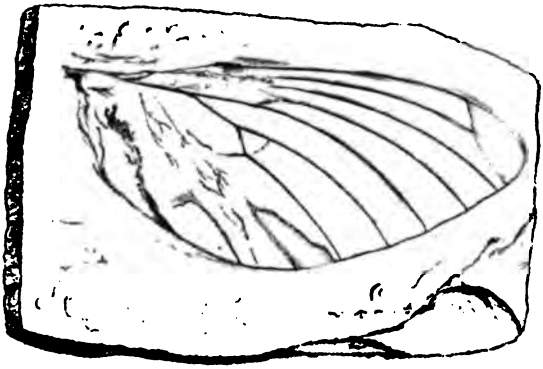

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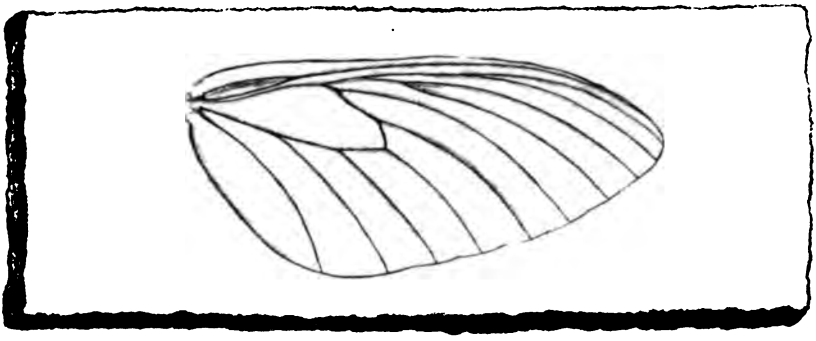

5.

A G. Butler del et lith.

Mintern Bros. imp.

1. Wing of Dasyophthalma.
2. Wing of Cicada.
3. Pupa of Cicada.
4. Palœontina Oolitica.
5. ....,, ...,, ...(restored.)

w them both the same day, and took tracings of them, so that I n confident they are really reverses. That of the Jermyn Street useum is more perfect than the one you saw in some particulars, pecially in giving *clearly* the basal half of the inner border and me of the *cross*-veins, altogether proving that the insect was not a utterfly, but an Homopteron allied to some of the *Cicadæ*—a con- usion strengthened by the fact that I saw in Mr. Brodie's Collection ecimens which I could only refer to the pupæ of *Cicada*-like imals of just about the size this wing would require. I was very rry to make such a discovery; but I think, if you re-examine the ecimen and compare it with its reverse, that you can scarcely fail agree with me."

In answer to the above, I told Mr. Scudder that Mr. Charles- orth's fossil had been examined at a full Meeting of the Entomo- gical Society, at which Prof. Westwood presided, and that both he, r. Bates, and other eminent Entomologists present, had agreed that had rightly determined the position of the genus; also, that I saw resemblance whatever between my fossil and an Homopterous sect. I received (two months later) the following reply:—

"I inclose a rough tracing of the sketch I took of the Jermyn treet 'fossil butterfly'—the original made by tracing from the one, and the more delicate and inconspicuous parts filled in after- ard. I do not see how you can possibly reconcile this to the uration of any family of butterflies, and there are distinct features hich make it decidedly anti-lepidopterous."

"You are the only living person I know of, who has devoted imself directly to the neuration of butterflies, so that I should have ore faith in your judgment than," etc., etc.

The "tracing" inclosed in the above certainly looked exceedingly ti-lepidopterous, and determined me to go and see the Jermyn reet fossil for myself, and this I took the first opportunity of doing.

I found the impression far inferior to Mr. Charlesworth's counter- rt, to which it undoubtedly belongs. It is in every respect less rfect, the base, front margin, apex, and part of the external angle the wing being broken away. Although I searched carefully, I uld find no cross-veins; but Mr. Newton very kindly pointed out rtain stained appearances as Mr. Scudder's cross-veins; they can ly be seen in certain lights, although well marked on the type, d clearly indicated in my figure in "Lepidoptera Exotica." In ort, I could see hardly any resemblance between the fossil and r. Scudder's tracing, and I wrote to him to that effect.

A short time since, I noticed the following, in the Proceedings of e Boston Society of Natural History, vol. xvi. p. 112 (1874):—

"Mr. Scudder exhibited a figure of an English fossil insect which d been described as Lepidopterous, and as one of the *Satyridæ*. he original specimen belongs to Mr. Charlesworth, and the reverse the Jermyn Street Museum. The neuration seems impossible for Lepidopterous insect, and resembles that of the *Cicadæ* more arly than anything else, but differs in the nervures at the base. Mr. *Brodie's Collection* Mr. Scudder found pupæ of Cicadinæ, which correspond to this insect in size, and are formed" [found?] "at the same, or nearly the same, geological horizon."

Seeing that Mr. Scudder had made his views public, I felt that it was time for me to take similar steps on my side. I therefore availed myself of an early opportunity of again visiting Jermyn Street, where, through the courtesy of the officers, I was enabled to make a sketch of the impression in the Museum. I found it impossible to make a tracing of it, and therefore drew the whole by measurement. This sketch is now produced on Plate XIX. Fig. 4; and anybody can judge for himself whether or not it is more perfect than that which I previously figured (see GEOL. MAG. 1873, Vol. X. p. 2. Pl. I. Fig. 2).

In order to show the extent to which the Jermyn Street example is deficient, I have restored it (Fig. 5), filling in the blanks from Mr. Charlesworth's specimen. By comparing the latter with the wing of *Dasyophthalma* (Fig. 1), and *Cicada* (Fig. 2), one may come to a pretty accurate conclusion as to the group of insects to which it ought to be referred.

If one compares Fig. 2 (the wing of a *Cicada*) with Fig. 3 (the pupa-case of a *Cicada*), it becomes a matter of doubt as to what Mr. Scudder means when he speaks of "pupæ of *Cicadinæ*, which correspond to this insect in size." Not having seen Mr. Brodie's specimens, I can only judge (from what I know of the relation in size of the wing in the pupa-case to that of the perfect insect), that they must be enormously too large for *P. oolitica*, and can have nothing to do with it: possibly, however, the Secretary of the Boston Society may have misrepresented what Mr. Scudder really said, for in his letter to me he says—"of just about the size this wing would require."

That Lepidopterous insects did exist in the Lower Oolite is now proved beyond doubt by the discovery of a second species, in the Collection of Mr. James Parker, of Oxford. The following is an extract from a letter received from that gentleman:—

"It is only a part of the wing, and in rather poor condition compared with Mr. Charlesworth's specimen. . . . . I took mine to our annual Warwick Meeting, to show rather the imperfect state of preservation which we must expect, even if Lepidoptera existed in abundance, and argued upon their unpreservable nature as compared with other remains. It so happens Westwood was talking to me a day or so ago about another matter, and I showed the specimen to him. He is going to draw out the probable lines of the veins where the specimen ceases. There is a little difficulty about the two lower veins, as they appear to curve round downwards, and not to meet, as they ought to do; still he has little doubt as to the Lepidopterous character. (So in the same way he does not hold to Mr. Scudder's opinion about Charlesworth's specimen. He has no doubt it is to all intents and purposes Lepidopterous.)"

When I have so great a champion on my side as the author of the "Genera of Diurnal Lepidoptera," and when I know that Mr. Bates *also* (*the* author of our present recognized classification of butterflies) agreed with me, when I exhibited the fossil, that it was properly placed in the Lepidoptera (*Brassolinæ*, not "*Satyridæ*"), I may safely remain steadfast in my original opinion, reminding my friend Scudder that though I am not infallible, neither is he, but at the same time two heads are better than one.

III.—ON THE MICROSCOPIC STRUCTURE OF THE LAMBAY PORPHYRY (OR PORPHYRITE).[1]

By Professor EDWARD HULL, M.A., F.R.S., President R. G. S. I.

THIS very handsome rock forms almost the whole surface of the Island of Lambay and of the adjoining coast, a few miles to the north of Dublin Bay. It is also laid open in the railway cutting at Donabate Station; and has received considerable notice owing to its intrinsic beauty as an ornamental stone, and its proximity to the Irish metropolis. I am informed by Rev. Dr. Haughton that he has identified specimens from the tessellated pavement of St. Kevin's Church, Glendalough, of the seventh century, which were submitted to his inspection by Sir W. Wilde. A polished table, together with a large block presenting two sides cut and polished, are placed in the gallery of the Royal College of Science in St. Stephen's Green; where, to those familiar with the marbles of Italy and Greece, the appearance of these specimens cannot fail to recall the green porphyry (*Marmor Lacedæmonium viride*) so largely used in ancient decorative works of art, and often reset in modern ones, the source of which is in the neighbourhood of Sparta and Marathon.[2] The two rocks, however, though resembling each other in appearance, are essentially distinct as regards mineral composition, M. Delesse having proved that the Grecian porphyry contains augite as an essential, and is apparently a porphyritic basalt, while the Irish porphyry is altogether destitute of this mineral. As regards geological age, the Lambay porphyry appears to have been intruded amongst the Lower Silurian rocks at a period antecedent to that of the Old Red Sandstone,[3] as this latter formation overlies the porphyry without appearing to have undergone any alteration along the surface of contact.[4]

The appearance of the porphyry is locally variable; but in its normal condition it consists of a dark green base, inclosing numerous pale green crystals of felspar. These crystals are of various sizes up to an inch in length. Occasionally there are cavities inclosing seggregations of chalcedony, epidote, chlorite, or calcite, which also fill in little veins and fissures in the rock itself. In some places it is highly vesicular, the cells containing flesh-coloured calcite. The late Professor Jukes and Mr. Du Noyer appear to have considered the rock to be hornblendic—attributing the dark colour of its base to the presence of this mineral; and on the Maps of the Geological Survey it is named and coloured as "Greenstone Porphyry." But the thin translucent slices, one taken from Lambay Island, and the other from Portraine, fail under the microscope to reveal this mineral; while, on the other hand, they show that the dark colouring of the base is due to its being highly charged with minute crystalline grains of magnetite, together with which is a little chlorite, imparting the greenish tinge to the rock.

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[1] Read before the Royal Geological Society of Ireland, 13th April, 1874.

[2] E. Hull, "Building and Ornamental Stones of Great Britain and Foreign Countries," p. 73.

[3] Maps of the Geological Survey, Sheet 102, with Explanation by Messrs. Jukes and Du Noyer.

[4] It is represented in a similar manner in Griffith's Geological Map of Ireland. Edit. 1855.

While, therefore, from the character of the rock, it is by no means improbable that hornblende occurs as an accessory in some places, yet on the whole it ought to be regarded as a felstone porphyry; or, to adopt Naumann's term for the quartzless varieties of porphyritic felstones, "*a porphyrite.*"[1] We shall now proceed to consider its microscopic structure in detail, beginning with the base.

The Base.—When a thin slice is examined with a moderate power (magnifying from 24 to 100 diameters), the base is seen to consist of a colourless felsitic material, amorphous, but sometimes containing long minute felspar crystals. Throughout this base small black crystalline grains of magnetite are distributed in immense numbers, often so small as not to come into sight till viewed with a high power. Along with the magnetite, a mineral which I take to be chlorite is abundantly diffused in the form of light green clouds, or else filling up along with calcite cavities and minute fissures. The dense and dark appearance of the base is therefore evidently due to its being charged so fully with magnetite, while the greenish tinge is due to the green structureless mineral which is more or less generally distributed throughout the felsitic base; and which, in all probability, is chlorite.

Orthoclase crystals.—These are abundant, and sometimes well formed. They frequently occur in pairs, sometimes in threes, less frequently in the form of a cross. They vary in size from half an inch downwards. In colour they are pale green, mottled white, and under the microscope are seen to be traversed by cleavage planes and fissures in various directions, altogether different from the fine parallel lines and bands which characterize the triclinic group of felspars. Occasionally, however, a banded structure parallel to the sides of the prism is observable in some of the crystals displayed on the polished block in the Gallery of the College of Science.

Magnetite.—Small black grains of magnetic iron-ore are so abundantly distributed throughout the base as almost to obscure it, unless the slice is exceedingly thin. Along with these are also occasionally larger perfect cubes, showing well-defined angles of 90° as estimated by the eye. It is remarkable, however, that it is only at rare intervals that a crystal of magnetite becomes enveloped in one of the felspar crystals, from which it may be inferred that these latter were consolidated while the iron remained dissolved throughout the materials from which the base was ultimately formed.

Very singular, however, is the manner in which these magnetite grains are arranged around the interior of some small cells, as shown n Fig. 1. Here they assume a stellate, or plumose arrangement, ranching out from certain centres placed at intervals around the ides of the original cell, now filled in with chlorite and calcite. his structure I regard as due to polarity, the magnetite grains aving arranged themselves side by side somewhat in the manner in which steel dust will arrange itself between the opposite poles of a magnet. Dr. Reynolds, however, suggests that the structure is imilar to the dendritic form assumed by manganese ore between the aminæ of sandstone or shale, and which he has shown to be due to magnetic force. In this case he supposes the cleavage planes of the alcite to have afforded the necessary conditions.

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[1] B. von Cotta's "Lithology," English Version, pp. 168-9.

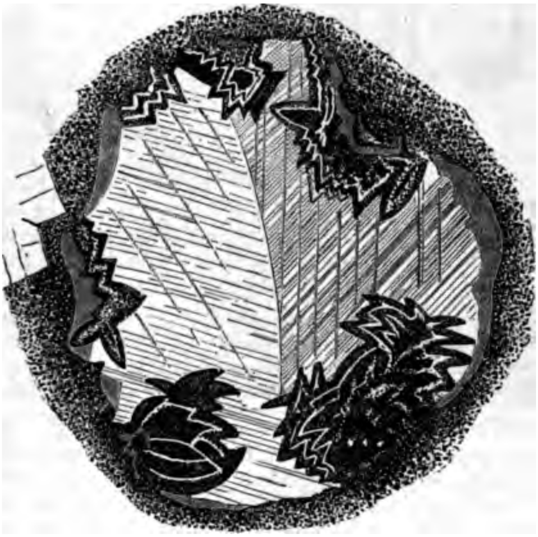


Fig. 1.—Cell in the porphyry lined with chlorite and filled with calcite. Several stellate prominences formed of minute grains of magnetite project from the walls of the cell into the interior, and are imbedded in calcite. Mag. 25 diams.

Chlorite.—This mineral is abundantly disseminated throughout the base. It also occurs in small irregular grains, or (along with calcite) fills in cracks and cavities in the rock. It is of a pale leek-green colour, structureless, but often inclosing minute cells, probably gas or air bubbles, as shown in Fig. 3. It is to be presumed that this mineral is in every case of secondary origin, and is not directly the product of igneous fusion. It has therefore been introduced by the agency of water, which has permeated the whole mass of the rock through channels inconceivably narrow, and which can only be revealed by the aid of a high microscopic power. In the section of the cavity (Fig. 1) which has been filled in by this material and calcite, the chlorite *forms a partial* lining, interposed between the *walls of the cavity* and the calcite which fills the interior, so that it in the service, as he taxed his constitution with more work than it could stand. During our work we received valuable aid from Doctors King and Melville, of Queen's College, Galway, and Prof. Harkness, of Cork; also from Sir R. Griffith, Bart., the latter veteran geologist, on account of his universal knowledge of the geology of Ireland, having given us invaluable hints and suggestions.

Prior to the work of the Survey, which took seven years to complete, this country seems only to have been consecutively examined by Sir R. Griffith. This observer studied it first about the year 1839, and detected fossiliferous unaltered rocks lying unconformably on metamorphosed rocks. The first by the fossils he knew to be of Upper Silurian age, while the latter he considered to be of the same age as the rocks in the counties of Wicklow and Wexford, in which Lower Silurian fossils were afterwards found. Subsequently this country was traversed by the late Sir R. I. Murchison and Prof. Harkness, both of whom from their published accounts are found to consider Sir R. Griffith's suggestions correct. The officers of the Geological Survey, after considerable labour, were in part able to confirm this opinion, as will appear from the description of the rocks.

The newest rocks that occur in this country are of Carboniferous age. To the north Carboniferous Limestones occur in the neighbourhood of Clew Bay, and from that they extend first eastward and then southward to Galway Bay, forming a boundary to the older rocks. Besides this large tract, small outliers of Carboniferous rocks occur in various places, consisting of sandstones, conglomerates, etc., which have been detected in various widely detached places, and thereby proving that the rocks of this age once covered the whole country; while the flattish tops of some of the highest hills are portions of the bottom of the ancient Carboniferous sea.

The next rocks in descending order are of Upper Silurian age, but of these there are two distinct sections in the area—one given by the rocks in the N.E. portion of the country, and the other by those to the S.W.

South-west Section.		North-east Section.
Salrock beds.	b^5	
Lough Muck beds Interbedded felstones Gowlaun beds .	b^4	Mweelrea beds and Tourmakeady beds
	b^3	Interbedded felstones.
		Unconformability.
Unconformability.	β^{11}	Doolough beds.
Schist.		

The Mweelrea beds b^4 probably in parts represent both the Salrock and Lough Muck beds, the lower portions of the Mweelrea beds being of Upper Llandovery age, while the upper part is of Ludlow, similar to the supposed age of the Salrock beds. They are, however, so very differently constituted, that they have been separated. The difference in the rocks in these sections seems to be due to the country to the north-east having been dry land for a considerable time after the country to the south was submerged and rocks were being posited in it. After the great fissure irruption, however, when the first of the sheets of felstones was poured out, all the country became submerged; but in the north country the accumulation partook more of shore depositions; so that there conglomerates and sandstones are the prevailing rocks, while in the south country there are large thicknesses of argillaceous rocks.

The Upper Silurian rocks lie unconformably on rocks that are more or less altered. To the north of the Upper Silurian rocks in the neighbourhood of Doolough, and near Lough Mask to the east, the lower rocks are only slightly mineralized, and belong to the rocks called by the Indian Surveyors "Sub-metamorphic." In some of these, fossils are preserved, so that we have been able to determine that the Doolough beds are of Lower or Cambro-Silurian age. To the south of the Upper Silurian rocks the lower rocks are much more altered, some indeed having lost all traces of their sedimentary character, and been changed into different varieties of granite. In none of these rocks, although some to the extreme south, at Lettermullen, are very little altered, have we been able to detect fossils; yet we believe they are of Lower or Cambro-Silurian age, and that if disentangled, they would lie in a great undulatory anticlinal curve that sinks towards the east and rises to the west, so that only in the neighbourhood of the Atlantic are the lowest beds brought to the surface. The rocks forming this curve can be divided into groups that are represented in both arms of the curve, and only slightly differ in thickness (*see Sections, page* 456):—

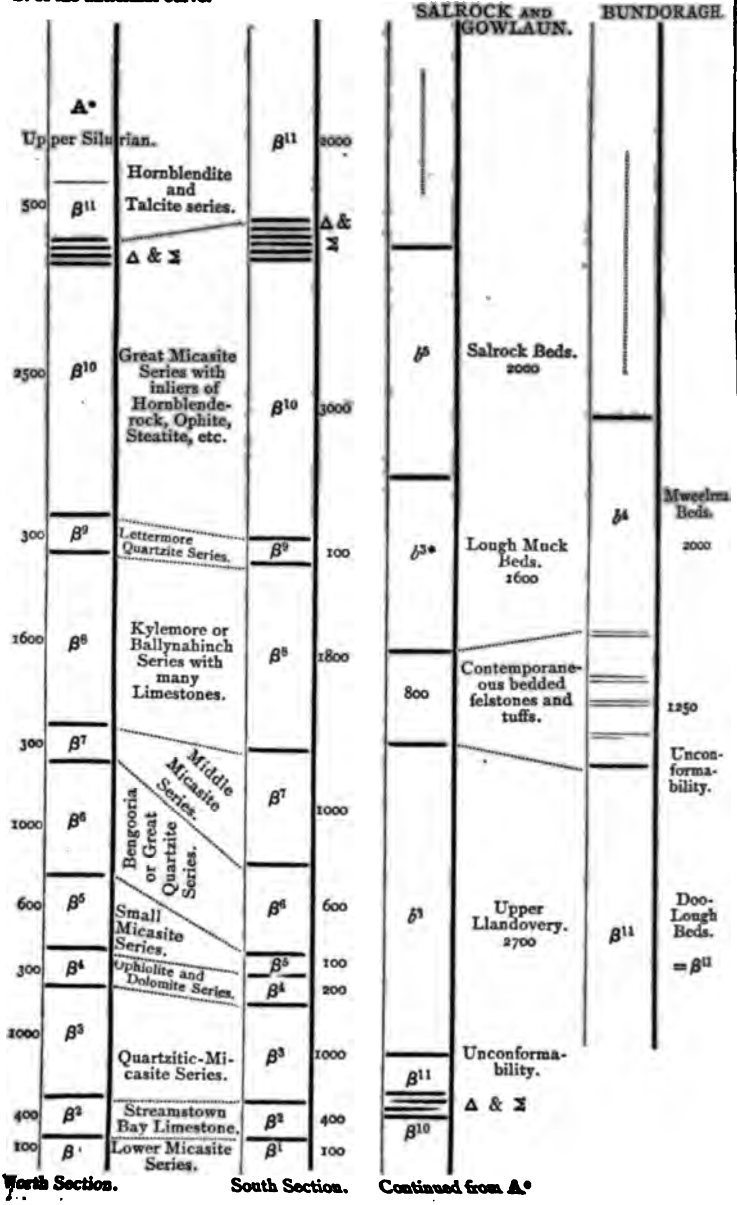
North arm.					South arm.
over	600 feet	β^{11}	Hornblendite, talcite, and felsitite series	*over*	2000 feet.
about	2500 „	β^{10}	Great micasite series with inliers of hornblende-rock, ophite, steatite, etc.	about	3000 „
„	300 „	β^{9}	Lesser quartzite series	„	100 „
„	1600 „	β^{8}	Lake series containing many limestones...	„	1800 „
„	300 „	β^{7}	Middle micasite series	„	1000 „
„	1000 „	β^{6}	Great quartzite series	„	600 „
„	600 „	β^{5}	Small micasite series	„	100 „
„	300 „	β^{4}	Ophiolite and dolomite series	„	200 „
„	1000 „	β^{3}	Quartzitic-micasite series	„	1000 „
„	400 „	β^{2}	Streamstown Bay limestone series	„	400 „
over	100 „	β^{1}	Lower micasite series	over	100 „
	8,600 feet.				10,300 feet.

In the south arm more of the upper rocks β^{11} are seen than in the north arm, as in the latter place a considerable portion is covered by the Upper Silurian; but to the north of the latter there is a vast thickness of the "Doolough beds," which are supposed to be the representatives of β^{11}. The lower Groups β^{1} to β^{3} are only positively known to exist in the vicinity of Streamstown Bay, a fiord from the Atlantic, although some of the limestones in the Owenglin Valley may belong to Group β^{2}. Groups β^{4} to β^{11} are found in various places, but rarely in consecutive order, as, on account of the innumerable faults, the same group or groups may be repeated, or one or more groups may be cut out.

In this country it is evident that the metamorphism is not due to the granite, *but that* the granite is due to the metamorphic action;

IARCONNAUGHT.
Sections showing the average thickness of the Metamorphic Rocks on the N. and S. of the anticlinal curve.

UPPER SILURIAN ROCKS
Showing the difference between the South and North Sections.



and the metamorphic rocks may be divided into three groups, all of which graduate from one to another :—

III. Schist Series.
II. Gneiss Series.
I. Granite of metamorphic origin.

The rocks in Group I. are perfectly crystalline, and usually have lost all their sedimentary characteristics; but between them and the rocks in Group No. II. there is a regular gradation; while Group II. graduates into Group III., and the latter into unaltered rock.[1] Besides the granite of undoubted metamorphic origin, there are other granites, evidently intrusive, with numerous Plutonic rocks. The granites are of two ages, one being *Pre-Llandovery* but Post-Cambro-Silurian, and the other *Post-Llandovery*, and probably Pre-Wenlock.

The Plutonic rocks can be divided into two groups—*Felstones* or siliceous, and *Whinstones* or basic rocks. The felstones seem to be of at least five different ages: *First*, Cambro-Silurian (?) age. These are all more or less metamorphosed, some into granitoid or even granitic rocks. *Second*, Pre-Llandovery age. These are newer than the time of the metamorphism of the Cambro-Silurian rocks, but older than all the Upper Silurian rocks. *Third*, Llandovery age. These are principally represented by bedded or interstratified basic felstones, that answer to the description of the rocks called eurites by Daubuisson, associated with which are tuffs, and in places limestones, the latter containing Upper Silurian fossils (Llandovery). *Fourth*, Ludlow? age. These occur bedded in the upper portions of the Salrock series (Ludlow?), and are eurites similar to the Llandovery eurites (No. III.). They were only found in one place south of Leenaun, but in the Loughnafoey district similar rocks, but intrusive, appear—coming up along the line of break by which the Salrock beds were let down against the Toormakeady conglomerates. And *Fifth*, Post-Silurian. These may be of any newer age. All we can prove about them is, that they are of subsequent age to the Salrock beds, the newest Upper Silurians in the country.

The whinstones, somewhat similar to the felstones, are divisible into; *First*, Cambro-Silurian age. These are all more or less metamorphosed, and the major part occur as bedded rocks. *Second*, Pre-Llandovery age. These are evidently newer than the time of the metamorphism of the Cambro-Silurian rocks, but appear to be older than all the Upper Silurian rocks. *Third*, Llandovery age. Bedded dolerites in the Toormakeady conglomerates. *Fourth*, Post-Silurian age. These rocks occur as dykes breaking up through the Salrock beds, but none of them were found associated with the Carboniferous rocks of the adjoining country. *Fifth*, Carboniferous age. These consist of dolerites similar to those that in the adjoining country occur associated with Carboniferous limestone. They are evidently newer than all the other whinstones; but they are very similar in aspect to the dolerites in the Toormakeady conglomerates.

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[1] These gradations the author fully explained in a similar manner to that given in his book "*Handy Book of Rock Names*" (Hardwicke), to which the reader is referred.

Faults and Dislocations.

The rocks in this area are cut up and displaced by an innumerable series of faults and dislocations, some being Post-Glacial, while the oldest may be Cambro-Silurian; and on account of the numerous rock exposures, it is evident that all the features of the country are due to these shrinkage fissures, they having induced the subsequent denudation,—valleys, fissures, and cracks having formed in those places where the "fault-rock" was weak, or the ground broken by dislocations; while in other places, where the fault-rock was of a harder nature than the associated strata, portions of the dykes form peaks and ridges. The newest faults seem to form the most continuous features, while in some of the older ones the displacement of the rocks is enormous. The latter, however, probably was not accomplished at one time, but by different movements in successive ages along the same line. This is quite evident in some places, as will be hereafter mentioned.

Clifden Fault.—This is one of the most continuous faults. It is probably of Post-Glacial age, and can be traced from Dogsbay, three miles west of Roundstone, north-north-westward, through Lough Fadda, to the town of Clifden, and from thence into Cleggan Bay. This fault displaces everything except the more recent peat; but along portions of it there is evidence to prove four at least distinct movements, one of which occurred prior to the associated rocks being metamorphosed, as in places there are detached portions of a dyke of metamorphosed fault-rock.

Doolough and Maum Valley Fault.—This fault can be traced across the whole country, and probably is very recent. To the N.W. it begins at the Atlantic Ocean, and can be traced through the valley of Doolough to Killary Bay, and from that along the Maum valley, through the N.W. arm of Lough Corrib, and along the valley of the Owenwee, into the Clifden and Oughterard Valley, south of which its position is obscured by deep bog, but it probably extends along a string of lakes into Galway Bay. All the faults that extend southward into the low granite country are more or less obscure on account of deep bog, besides not making such marked features as elsewhere, and probably being of less magnitude.

Loughinagh Valley Fault.—This does not extend in so straight a line as those previously mentioned. It seems also to split and form two or more lines, but the deep bog in the valley may mislead the observer. To the N.W., in the Kylemore Lough Valley, there is a marked fault that turns S.E. into the Loughinagh Valley, where it seems to split into two great faults, one running S.E. and the other nearly due south.

Clifden and Oughterard Valley Fault.—This occurs in the valley between Clifden and Oughterard. In some places it would appear to be very recent, and to displace all faults it comes in contact with; while in others it seems to be displaced. It is, however, very hard to trace, on account of the deep bog and drift in the valley, the latter having been re-arranged during the "Esker-sea or the 350-feet beach period;" also that the fault in general runs nearly with the strike of the rocks. In places, however, it is very prominent, shifting the transverse faults. This and all other east and west faults are most important, as they cut out thick masses of the rocks; and to them are due some of the greatest complications in the geology of the country. Beginning at the west, we find the fault extending along the valley of the Owenglin, and bringing down on the south of it the rocks belonging to Group β^8 (see sections) into juxtaposition with much lower beds. East of Waterloo Bridge to Derrylea Lough, Group β^6 (Great quartzite) and associated rocks are on the north of the fault, while south of it are rocks belonging to Group β^8 (Ballynahinch series). A little east of Derrylea Lake a cross fault brings higher beds into juxtaposition with the Great quartzite series; and similar relations occur eastward to the *Benglenisky Summit Fault.* East of the last fault Group β^4 (Ophiolite and Dolomite series), or lower beds, occur on the north of the fault, while south of it are the rocks of Group β^8. Farther eastward to the *Lop Rock Fault,* which extends northward from the S.W. end of Derryclare Lake, the relations between the rocks north and south of the Clifden and Oughterard fault are still more complicated. East of the Lop Rock Fault, the Clifden and Oughterard fault may split, as a considerable fault extends along the valley of the Derryclare Lake. This line, however, is a downthrow to the N.W., and brings down Group β^6 against rocks of Group β^5.

Further eastward the main east and west fault has not such a striking effect, as its throw is not so considerable; for in the country south of Derryclare, at Lissoughter, and still farther east in the Corcogemore mountains, we find the rocks belonging to the different groups in more regular succession, and with their true dip southward; but in places the fault seems to cut out considerable portions of the thickness of Group β^8 or of one of the higher groups.

Maumina Fault.—This fault is evidently displaced by those previously mentioned, nevertheless it appears to be Post-glacial. To the S.W. it is met with at Mannin Bay, from which it extends nearly E. and W. to Croaghat Lake, being slightly shifted by the *Clifden Fault.* At Croaghat it joins into a N.E. and S.W. fault. From Croaghat it can be traced, forming a marked feature through Maum-inagh and Gleninagh, into the Lough Inagh Valley, where it is slightly shifted by the previously mentioned fault. From this it runs across the hills to Leenaun on Killary Bay, up the upper portion of that fiord, and along the Erriff and Aille river valleys into the Limestone country between Ballinrobe and Castlebar.

None of the other faults in the district seem to be so continuous, all being greatly shifted by more recent dislocations. Many, however, are very important, on account of the great displacements connected with them. Near the west end of Killary Bay, at the pass of Salrock, a fault brings down the Salrock beds against the Doolough beds, and this fault can be traced eastward to Lough Mask, but not continuously, as it is considerably shifted by other faults, the greatest shift being at the Maum Valley—the Maum Valley Fault shifting the *urites on the west of* the fault over three miles to the S.E.

Nearly parallel breaks to the south portion of the *Clifden Fault* have more or less formed the hollows now occupied by the lakes in the champagne country between Clifden and Roundstone, as most of them have their greatest length in parallel lines. This system of breaks, however, was associated with other systems, the most marked being those that range respectively N. and S., N.W. and S.E., and N.E. and S.W.; and with these different bearings, the principal long stretches of the lakes coincide, while every bay, creek, or gut, branching from one of these lake-basins was evidently originally formed along one of these or some minor break.

The north and south breaks are more conspicuous, and seem to occur more frequently in the country near Roundstone Bay than elsewhere, but in other places some were noted forming conspicuous features, such as the fault in the south portion of the valley of Lough Inagh, the fault in the pass called Maumwee between Shannaunnafeola and Lackavrea, the fault of the Owenwee valley, and others.

The system of breaks coinciding with the most marked valleys seems to be that which bears nearly N.W. and S.E., while the principal ridges among the hills south of Killary Bay have a nearly similar trend. Other conspicuous valleys are those that run along the east and west breaks.

That the bays, fiords, valleys, and hill-lines are due to the breaks is evident, as they occur in systems. The western portion of Killary Bay, and all the other submerged valleys now forming bays from the Atlantic, southwest of Killary Bay to Mannin Bay, have a general bearing of from N. 55 W. to N. 65 W., being to all intents and purposes parallel, this bearing also coinciding with that of the valley of Lough Muck on the south of the western portion of Killary Bay. Of E. and W. valleys we have the eastern portion of Killary Bay; Clifden and Oughterard valley, from the first town to Loughaunerin, and farther eastward from Lough Agnaffard to Lough Corrib; north of the latter, and of equal length, being the S.E. portion of Maum Bay. Another E. and W. feature is the valley from Cleggan Bay through Ballynakill Lake and harbour, and from thence through Kylemore Lake. A few miles further east the valley is crossed by high ground, but the line of break is visible, and still further east on it are situated the picturesque Loughnafoey and Derry Bay. Other E. and W. faults are also conspicuous, forming minor valleys. As before mentioned, the breaks are in systems of different ages, two of which, at least, are older than the intrusion of the oldest granite, as they are cut by veins from this granite; two, at least, are newer than the granite, but older than the Carboniferous rocks. One is known to be Post-Carboniferous, but Pre-Glacial, while two or three are Post-Glacial. Some of the N.W. and S.E. faults are very recent; these, however, in places run along lines of much older faults. The E. and W. faults would appear also to be very recent, but generally they appear to be displaced by the N.W. and S.E. faults. Some also the N.E. and S.W. faults seem to be Post-Glacial; they, however, evidently displaced by the N.W. and S.E. faults.

A summary of the facts collected while examining this district would seem to lead to the following conclusions:—

First.—The oldest rocks, which seem to be of Cambro-Silurian age, were deposited and acquired a thickness of many thousand feet; and during their deposition, but especially while the rocks in Groups β^{10} and β^{11} were accumulating, vulcanicity was at work,—rocks, both molten and in the form of tuff, being ejected from great fissures. The ejected materials formed extensive bed-like masses interstratified with the sedimentary rocks, while the portions that remained in the fissures now appear as dykes and intrusions among the lower beds.

Second.—The Cambro-Silurian rocks were crumpled, contorted, broken up and displaced, while their mineral conditions were changed; all the beds being more or less metamorphosed, some even graduating into granite. After these rocks were metamorphosed, there were intrusions of other granites.

Third.—A denudation that removed nearly all those parts of the Cambro-Silurian rocks that were unaltered, and a considerable portion of the metamorphic rocks, so that in some places the completely altered rocks (granite) were exposed; this is proved by the Upper Silurian conglomerates containing numerous blocks and fragments of the granite. The denudation must have been accompanied by a rising of the land.

Fourth.—A depression of the land, during which the Upper Silurian rocks were deposited. In this epoch there is also proof of vulcanicity, as, interstratified with the Lough Muck and Mweelrea beds ($b^{3\circ}$ and b^4), there are masses of tuffs and igneous rocks, associated with dykes and protrusions of granite and other Ingenite rocks.

Fifth.—An elevation of the land accompanied by denudation. This must have been going on for a vast length of time, as over large areas all the Upper Silurian rocks were denuded away, and probably portions of the Cambro-Silurian and the Granite, prior to any of the Carboniferous rocks being deposited, as the latter rocks rest not only on the upturned denuded edges of the Upper Silurian rocks, but often overlap them, and are found deposited on the granite and other hypogene rocks. Moreover, it appears probable that the denudation of the older rocks had almost ceased in this area when the Carboniferous rocks were deposited, as in only a few places, and these of small thickness, do arenaceous or argillaceous rocks intervene between the denuded rocks and the Carboniferous Limestone.

Sixth.—A depression of the land during the deposition of the Carboniferous rocks.

Seventh.—An elevation of the land while the Carboniferous rocks were denuded.

Eighth.—A vast time between the end of the Carboniferous period and the dawn of the Glacial, in which the events that happened are unrecorded. Newer rocks may have once covered the area; but if they did, they seem subsequently to have been removed, as no positive traces of them can be found in the Glacial accumulations.[1]

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[1] In one locality, Ballycurrin, on the east of Lough Corrib, a block of fibrous *gypsum was found in the drift.* This possibly may be a record of newer formations *than the Carboniferous.*

Ninth.—The deposition of the Boulder-clay and Moraine drifts.

Tenth.—The "*Esker Sea*" *Period*, when the waters of the sea rose about 350 feet higher than they are at present, during which time the Boulder-clay and Moraine drifts were in part denuded, forming sand and gravel ridges, sea-beaches and other records of this ancient sea.

Eleventh.—The waters sank about 250 feet, after which the *100-feet sea-beaches* were formed.

Twelfth.—The waters sank about 75 feet, after which the *25-feet sea-beaches* were formed.

Thirteenth.—The waters sank at least 55 feet.

Fourteenth.—The sea waters rose at least 55 feet, as bogs with "corkers" or roots of trees *in situ*, occur over 25 feet below the present sea-level.

Fifteenth.—A probable gradual fall of the sea-level at the present time.

V.—NOTE ON THE PHONOLITE FROM THE "WOLF ROCK."

By S. ALLPORT, F.G.S.

IN the GEOLOGICAL MAGAZINE, Vol. VIII. 1871, p. 247, I gave a short account of the composition and structure of a Phonolite which forms the mass of the Wolf Rock lying between the Land's End and the Scilly Islands. The account there given has been noticed by Prof. Zirkel in a work recently published,[1] in which he refers to my description of some of the crystals stated to be nepheline, and suggests that they may be nosean. The passage to which he refers is as follows:—"The grey dust filling some of the crystals is frequently collected together so as to form a dark or even black mass in the centre, the edges of which are sharply defined, and correspond exactly with those of the crystal. Hexagonal crystals, for example, exhibit a border filled with a fine grey dust, and a central portion occupied by a well-defined black hexagon, or there is sometimes a black band running parallel with, and at some distance from the sides." To this I may now add, that some of the crystals and irregular grains are traversed by a number of very fine straight lines of a bluish-black colour, and that with a high magnifying power these lines are resolved into rows of extremely minute dark granules similar to those forming the dust. This remarkable structure, combined with that previously given, is so thoroughly characteristic of nosean that there can be no doubt of its presence in the rock; the mineralogical composition of which is thus found to be in complete accordance with that of the large series examined by Zirkel.

Through the kindness of Mr. Beazeley, of Penzance, I have now a better and more characteristic specimen of the rock than those previously in my possession. It is in a remarkably fresh state of preservation, contains numerous visible crystals of glassy felspar in [illegible]mpact base, together with many dull blackish grains of nosean.

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[1] *Mikroscopische Beschaffenheit der Mineralien und Gesteine.*

The rock is quite fissile in one direction, but in others breaks with difficulty, and with a rough splintery fracture. A microscopic examination suggests, however, no further alteration in the description already published, and it is therefore evident that the "Wolf Rock" may be regarded as a typical Phonolite composed of nepheline, nosean, sanidine, hornblende, and a little magnetite.

The base, or mass of the rock, consists of small crystals of nepheline and felspar, the former being most abundant, numerous small yellowish-green prisms of hornblende are scattered through it, and then there are comparatively large crystals of sanidine, nosean, and a few of nepheline porphyritically imbedded in the mass. As this is the only English Phonolite hitherto observed, it affords a good illustration of the value of microscopic investigations, the result in this instance being the discovery of a rock and two minerals not previously known to occur in these Islands.

It may be observed in conclusion, that the rock does not exhibit the least trace of alteration in any of its constituents; and as it is mineralogically identical with the Tertiary phonolites, it is quite possible that it may belong to that period, although we have as yet no evidence of the extension of the great Tertiary volcanic eruptions to the southern end of our island.

NOTICES OF MEMOIRS.

I.—BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. FORTY-FOURTH MEETING, BELFAST, August, 20th—25th, 1874. LIST OF PAPERS READ BEFORE SECTION C. (GEOLOGY).

President—Professor EDWARD HULL, M.A., F.R.S., F.G.S.

The President's Address.

Prof. Harkness, F.R.S.—Sketch of the Geology of the N.E. of Ireland.

The Report of the Sub-Wealden Exploration Committee.

E. T. Hardman, F.C.S.—On the Geological Structure of the Tyrone Coal Fields.

Prof. A. Nicholson, M.D., D.Sc.—On a Remarkable Fragment of Silicified Wood from the Rocky Mountains.

Prof. A. Nicholson, M.D., D.Sc.—Description of New Species of *Cystiphyllum*, from the Devonian Rocks of North America.

Prof. A. Nicholson, M.D., D.Sc.—Description of Species of *Alecto* and *Hippothoa* from the Lower Silurian of Ohio, with a Description of *Aulopora arachnoidea.*

Prof. A. Nicholson, M.D., D.Sc.—Description of New *Polyzoa* from the Lower and Upper Silurian Rocks of North America.

Prof. A. Nicholson, M.D., D.Sc.—On *Favistella stellata*, and *Favistella calicina*, with Notes on the Affinities of *Favistella* and Allied Genera.

W. Pengelly, F.R.S.—Tenth Report of the Committee for Exploring Kent's Cavern, Torquay.

R. H. Tiddeman, F.G.S.—Report of the Committee for assisting in the Exploration of the Settle Caves (Victoria Cave).

Sir Willoughby Jones, F.R.G.S.—(Communicated by). Notes on Cavern Explorations in the Pyrennees by M. Frossard.

W. Chandler Roberts, F.G.S.—On the Columnar Form of Basalt.

W. H. Baily, F.G.S.—On the Coal-measure Fossils of Ireland.

G. H. Kinahan, F.G.S.—Geological Maps and Sections of West Galway and South-West Mayo, see *antè* p. 453.

W. Jolly—Third Report of the Committee for Collecting Fossils from Localities Difficult of Access in North-Western Scotland.

R. Russell, C.E., F.G.S.—The Permian Breccias of the Country near Whitehaven.
L. C. Miall—Second Report of the Committee on Coal-measure Labyrinthodonts. The Classification of the Labyrinthodonts.
H. Willett and *W. Topley*—Second Report on the Sub-Wealden Exploration.
Dr. W. B. Carpenter—Further Researches on *Eozoon canadense.*
J. Gwyn Jeffreys—Note on the so-called Crag of Bridlington.
E. T. Hardman—On the Age and Mode of Formation of Lough Neagh.
Rev. H. W. Crosskey—Report of the Committee for Recording Information on the Erratic Blocks of England and Wales.
J. Thomson—Report of the Committee for Investigating Mountain Limestone Corals.
Prof. A. S. Herschel and *G. A. Lebour*—Report of the Committee for Carrying on Experiments on the Conducting Power for Heat of certain Rocks.
Dr. Bryce—Report of the Committee for Observations and Records of Earthquakes in Scotland.
Joseph Wright—On the Discovery of Microzoa in Irish Flints.
Rev. Dr. Grainger—On the Fossils of the Post-Tertiary Deposits of Ireland.
Prof. Hull—On the Progress of the Geological Survey of Ireland.
W. A. Traill—On Geological Sections in the County Down.
E. T. Hardman—New Localities for Upper Boulder-clay in Ireland.
G. Langtry—On the Occurrence of the Middle Lias at Ballycastle.
Dr. Vaughan (communicated by F. Drew)—Physics of the Internal Earth.
Prof. J. Thompson—On the Jointed Prismatic Structure of the Giants' Causeway.

II.—NOTES ON THE GEOLOGY OF THE ISLAND OF YESSO, JAPAN, FROM OBSERVATIONS MADE IN 1862. By W. P. BLAKE.[1]

THE salient features of the geology of the Island of Yesso, Japan, are volcanic. Symmetrical cones, snow-capped for a great part of the year, are the first landmarks that greet the eyes of the mariner as he approaches the coast, and are the last to disappear as he leaves it behind. The cone of Esan, in a solfataric condition, forms the eastern and southern headland of the island, not far distant from the port of Hakodadi and from Komangadaki Mountain; another solfataric cone rises conspicuously upon the southern shore of Volcano Bay at about the same distance from Hakodadi. This last-mentioned mountain was in a state of violent eruption a few years ago, and threw out an enormous quantity of ashes, pumice, and hot water. Further north, beyond Volcano Bay, the beautiful cone of Shiribets is grouped with several others; all of them are remarkable for their symmetry and grandeur. Most of these volcanic mountains may be regarded as extinct, though many yield quantities of sulphur and emit steam. At an early period their activity must have been prodigious, for almost everywhere throughout the island, or at least the southern portion of it, so far as explored, there is a vast deposit of fragments of trachyte, lava, scoriæ and volcanic débris. These materials are generally in the form of a stratified brecciated conglomerate, sometimes alternating with finer materials, such as beds of sandstone and volcanic ashes.

A coarse conglomerate of this formation is found bordering the island from Esan nearly to Komangadaki, and extensively upon the western coast, as in the neighbourhood of Iwanai. It is also found extensively developed in the interior.

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[1] From the Transactions of the Connecticut Academy of Arts and Sciences, vol. ii. t 2. *Read* February 21, 1872.

Older and stratified formations appear to form the basis or foundaion for the volcanic formations. At Ota, on the west coast, granitic nd metamorphic rocks, in well-defined outcrops, form a rugged oast. In the interior they form the principal watershed, and give ise to many rivers, in the beds of which gold is found in deposits hich can be profitably worked. These metamorphic strata are plifted, and generally trend northwest and southeast, and show lexure and bending exactly as in other and better known regions. lates, sandstones, and limestones are found also at Esan, Shuokobi, nd near Kakumi, and at the lead mines of Ishinowatari and Urup. he rocks at the two last-named places are not as much uplifted and etamorphosed as the granitic and auriferous rocks, but they are robably parts of the same series of formations. The only recogizable fossil found is apparently a fragment of a Calamite, leading e to suspect that the beds are of Carboniferous age; but this is by o means certain, and although diligent search was made no other vidence of the age of these formations could be found. Near Iwanai here are beds of good coking coal in strata that have no lithological esemblance to the auriferous series, but they are uplifted at a high ngle. Fossils apparently of Cretaceous or Jurassic age are found n the eastern part of the island.

The next stratified formation of interest is marine Tertiary or Post-ertiary, which rests unconformably upon the older stratified beds, nd is highly charged in some places with well-preserved fossils carcely distinguishable from the mollusca now existing upon the oasts. In these deposits, and in later terrace-like formations, there s abundant evidence of the comparatively recent uplift of the whole sland, and the same evidences are found upon the island of Nipon.

Dynamically, the formation of greatest interest is without doubt he volcanic conglomerate and the associated beds of finer volcanic aterials. They record the most energetic volcanic action at an early eriod before the recent uplift, for it is almost certain that the mass f the conglomerate was deposited under water. It seems as if there ad been a series of violent subaqueous eruptions, perhaps at the ime the now-existing cones began to be formed. It is most probable hat the island has been gradually formed by the rising of these eparate cones above the sea, thus giving at first a group of islets, ach a volcano, similar perhaps to those which can now be seen off he coast and at the entrance to the Bay of Yeddo. One is repreented opposite the western coast on the Japanese maps.

REVIEWS.

GEOLOGICAL SURVEY OF YESSO.

IT may be news to some readers of the GEOLOGICAL MAGAZINE to learn that there is a Geological Survey in progress in Japan; but he fact is recalled by the appearance of the "Preliminary Report on he First Season's Work of the Geological Survey of Yesso," the large orthern island of the group, by Mr. Benjamin Smith Lyman, an American Mining Engineer of experience, a few years since specially retained by Government to explore the petroleum grounds of India—a work which came to an abrupt end after Mr. Lyman's examination and honestly unflattering Report of the Punjab Oil Lands was published.

Mr. Lyman now signs himself at Shiba, Yedo, Chief Geologist and Mining Engineer of the Geological Survey of Japan. His assistants are Mr. Henry S. Munroe, a fellow-countryman; Mr. T. Yamauchi, Mr. H. Satow (Interpreter, etc.), Messrs. Inagaki, Kuwadá, Misawa, Takahashi, Kada, Saka, and Saito, with Mr. Y. Akiyama, and Mr. S. Ichichi, Quartermasters to the two American gentlemen.

Of the whole of these, the head of the Survey reports favourably, and says of the eleven Japanese, that even though young and inexperienced, and for the most part wholly ignorant at the outset, not only of geology, but of surveying, drawing, and even almost of common arithmetic, they have been very useful, partly because they have eagerly and rapidly learned what they could in a very short time, and partly because such surveys require much work of comparatively simple character. He notices the benefit to themselves and to the empire of the knowledge they have gained by their season's labour, adding, "They are not only the first Japanese, but the first Asiatics to undertake the study and practise of geology; and although the training of native geologists in India has been begun nearly at the same time (or is soon to begin), I trust that ours will continue to take the lead, and that Japan will become in a few years independent of foreign countries in their profession." This might by the author's countrymen be called rather "tall talk," after eight months' progress from the state of ignorance described; but the chief of the Survey writes, to say the least, hopefully; and we may perhaps expect to see the march of geological science yet aided by the writings of our precocious but distant Japanese brethren in these very pages.

The Preliminary Report is little more than a pamphlet of 46 pages, published at Tokei by the Kaitakushi, and unaccompanied by maps or sections; still its printing and general neatness of production would compare most favourably with anything of the kind in Europe or America.

The survey of the ground itself has evidently to be topographically made, contemporaneously with its geological exploration; doubtless a great advantage. We observe, however, that Mr. Lyman is pursuing the system of Prof. J. Peter Lesley, of Philadelphia, namely, the delineation of the surface of the ground on the map by contour lines, and also by imaginary contours of the strata underground, endeavouring to show their positions at various depths, and also at the outcrop. This we look upon as a mistake. In the first place, the system can only be applied to stratified rocks, and would only give approximately correct results if the bands were always equidistant, and the curves of the strata themselves of fixed geometrical forms. Observations made at the surface can only be taken

; and even if the strata were always as

learly traceable over the ground as the bands of an Agate, the spection of any large highly contorted cliff section will show how ttle one can presume upon the indications of curvature near the urface for exact knowledge of how the strata are relatively placed ith regard to the continuation of these curves in depth, so that it s too much to expect, with Mr. Lyman, that "the contours of any ock bed or vein may be drawn as it is under ground, and its connts above or below any given level or within any given limits ay be calculated."

Again, the confusion and unsightliness of so many lines upon a ap—the contours of the ground and those of the *supposed* places of eds below the surface crossing each other at all angles—would create bscurity. Cases may exist in which, the strata not being greatly ontorted or faulted, such a map, with lines of different colour for ontours of the ground and of the rocks, might be useful to a miner, ut for general geological purposes such maps could never be comared with ordinary geological maps and sections.

The geological part of the Report is interesting but scanty, though he district appears to contain much variety of volcanic, Tertiary, rystalline, and other rocks. It can be readily understood that the ull arrangement of notes and observations could hardly be accomlished for a mere Preliminary Report, but something more might ave been expected than the classification of the series by their ystems of disturbance and the parallelism of certain axes to the rend of certain coasts, the author being from one passage evidently ell aware "that the same system of folds might affect rocks of very ifferent age."

The following list of rock-groups is given, it is presumed in natural escending order:—

Alluvium, new and old.
Volcanic pebble rocks.
Volcanic rocks.
Rocks of the Horumui Karafto system of folds.
Coal-bearing rocks or rocks of the Horumui Kuril system of folds.
Rocks of the Horumui Karafto system of folds.
Rocks of the Toshibets Kuril system of folds.

In the Alluvium peat is found, and also lignite with distinct woody ibre.

The Volcanic pebble rocks (conglomerates) are thought to rest onformably on the Coal-rocks at high angles.

The still slightly active volcanos are chiefly along the shores of Volcano Bay and the adjacent coast. Six of them are mentioned, he only recent ejections besides vapours being pumice; and one of he last eruptions (a small one) having taken place on the 1st of March, 1867. Many more of the volcanos of the island have long een quite extinct.

The axes of the Toshibets group strike nearly north and south. At the gold-fields of the same name the rocks in some localities conain great numbers of the "tubes of tube-worms" (Dentalium?) and '*modern looking shells.*" The rocks are soft and of recent aspect, containing brown lignite. Mr. Munroe places their thickness a 3000 feet, with reddish-brown sandstone at the base. What the upper portion may be is not stated.

The Coal-bearing rocks are mostly light grey shales, with a three-foot bed of limestone. They are contorted, striking N. 50° E. (magnetic). They seem to be Tertiary, judging from "fossil leaves in the shales." A number of fossil shells found in the Horumui field will probably fix the point. This is the third Coal-bearing group (from above downwards). The coal is similar to that of the Rocky Mountains, of about the period of the latest Cretaceous or earliest Tertiary deposits.

The Horumui Karafto System.—These bluish grey shales and conglomerates, like the rocks of the Toshibets system, strike nearly north and south. They are 600 feet thick, seem to underlie the Coal rocks, and are older looking than these, as if somewhat metamorphosed. The pebbles are of crystalline rocks, and are not seen in the overlying beds. No fossils have been found in them. An old-looking limestone, much cleaved and apparently metamorphosed, is thought to have been folded [contorted] by a later action than that which affected the Horumui Karafto system.

The Toshibets Kuril System.—A syenite group, striking N.E.-S.W., is supposed to have furnished the pebbles of the overlying rocks.

From the disturbances of the above rocks it is inferred that the strata of the island have been twice folded alternately about northerly and north-easterly.

The palæontology of these rocks is a point reserved for determination of the fossils, there being no means of accomplishing this in Japan.

The useful minerals noted are coal, ironsand, sulphur, lime, stone, gold, rock-tar, mineral springs; traces of silver, lead, zinc, manganese, and copper. About half the Report is devoted to these.

The Coal is a brightly shining brown coal, in six workable beds of 3 to 8 feet, probably of Tertiary age.

A sample examined by Mr. Munroe contained—

Moisture	3·8	
Volatile matter ...	39·5	
Fixed Carbon ...	52·4	Coke (friable and dull, 56·7
Ash (fawn colour)	4·3	

The magnetic ironsand on or near the coast has been apparently derived from the volcanic rocks. Part of it smelts easily; part with difficulty, owing to the presence of titanium. It was formerly worked to some extent.

Sulphur occurs mostly within craters of inactive volcanos or on close adjoining outer slopes. The mineral is traced to the volcanic fumes. Its manufacture or refining consists simply in melting the natural accumulation three times, and straining through thick canvas, the production of one place being 16 tons in three months. Horses could go all the way to the mines, and it is thought that melting the sulphur upon the shore would be more advantageous than at its sites. The abundant exhalations at Tarumai and Esan volcanos must [illegible] rapidly adding to the deposits, but how rapidly there is no means [illegible]ging.

At another place called Kobui the sulphur is of a grey colour and deposited by water. It is very pure, but irregularly accumulated.

The limestone of dark grey and light blue colour is cleaved, metamorphosed, and unfossiliferous. Its quantity is stated at so many millions of tons.

Gold occurs in small grains and scales in the alluvial gravel that borders the river of the Toshibets. This gold alluvium is in one place $3\frac{6}{10}$th miles in area, and 6 to 12 feet thick, containing, say, a million and a half of dollars worth. Other fields are smaller, and one is on mica-schist and metamorphic rocks. The total value is estimated under two and a half million dollars, and it is not thought to give much encouragement for working.

The rock-tar comes from the Toshibets Karafto system. It is in soft bluish-grey shaly sandstone (Tertiary ?). There are moreover oil wells having a small yield.

Of mineral springs there are 21. Thirteen of them are sulphur springs, varying in temperature from coldness to boiling; six iron springs from 27° to 91°; one cold spring with copperas, and two nearly pure springs of 30° to 50° of heat.

Small quantities of pyrites, calcspar, kaolin, oil-gas, and some "justly abandoned" lead-mines are also mentioned.

The climate of the country seems to be severe, with snow early in November, but the winter months give a recess season for working out in detail the field operations of the Survey.

From the above it will be seen that the geology of Yesso and the First Report of its Geological Survey abound in interest. Hence we may expect future details to be instructive; and we trust the energetic and painstaking Chief Geologist may be enabled to bring his undertaking to a successful issue. W.

REPORTS AND PROCEEDINGS.

GEOLOGISTS' ASSOCIATION.

I.—EXCURSION INTO NORTHAMPTONSHIRE.—Whit-Monday, May 25th, 1874, and following day. Director, Samuel Sharp, Esq., F.S.A., F.G.S.

The party, numbering about 16, was met by Mr. Sharp at Blisworth Station at 10·30 A.M. Mr. Sharp at once proceeded to give an outline, illustrated by a diagram, of the formations in the district through which he proposed to act as conductor.

Proceeding upwards from the clays of the Upper Lias, we have a series of beds, which, as developed in the neighbourhood of Blisworth and Northampton, sometimes attain a total thickness of 80 feet. These consist in their lower portions of ironstones, often of great commercial value. The middle portions yield a red building stone, much used in, and very characteristic of, the county; whilst the upper portion consists of white sands, frequently containing a plant-bed, and usually characterized by vertical plant-markings. This latter is designated the 'Lower Estuarine Series,' the whole group being referred to the Inferior Oolite. Throughout the country visited, extending from Blisworth in the S.W. to Stamford in the N.E., points upwards of 40 miles apart, the sequence above detailed holds true in the main for all portions of the district. When, however, we get above the Lower Estuarine bed, an important difference is observed to occur. At Blisworth and Northampton, reposing immediately, and perhaps unconformably, on the last-mentioned bed, occurs a bed of blue clay, containing wood, plants, and bands of shells, some of which are said to be fresh-water forms (*Cyrena*, etc.). A ferruginous band occurs at the base. This clay has received the name of the Upper Estuarine Series. It is succeeded by about 25 feet of a white marly limestone, full of marine shells, above which, where the sequence is complete, is another clay, with abundance of *Ostrea subrugulosa.* These three beds, viz. the two clays and the intermediate limestone, are referred to the Great Oolite. Above all, there is frequently a capping of Boulder-clay. As we proceed north-eastwards, however, it is found that the beds called Upper and Lower Estuarine are no longer in contact, but that there is intercalated an Oolitic Limestone, which presently assumes considerable importance, and at Stamford, on the N.E. extremity of the district under consideration, attains to a thickness of 75 feet.

This formation last referred to is called the Lincolnshire Limestone. The party then proceeded to inspect the Blisworth Ironstone Diggings, about one mile and a quarter east of the station. This quarry has a face, including the "baring," of about 30 feet. The base, or junction with the Upper Lias, was not actually observed, but the Lower Estuarine is seen at the top. The ironstone exists principally as a sesquioxide, and that portion selected by sifting is said to contain as much as 40 per cent. of metallic iron. Few, if any, fossils were found by the party in this quarry, although Mr. Sharp has obtained many—all, or nearly all, as casts.

About a mile further on, a quarry in the Great Oolite Limestone, extracted chiefly for building, was visited. Here the party had an opportunity of observing about 18 feet of Boulder-clay, between which and the limestone there occurs about 18 inches of clay referred to the period of the Great Oolite. Several characteristic fossils were found in this quarry.

The town of Northampton, at present containing a population of about 45,000 inhabitants, is very favourably situated upon an angle of high ground, sloping rapidly towards the river Nene on the south and towards the northern branch of the Nene on the west. The valleys of these streams are excavated in the Upper Lias. The bulk of the town, therefore, rests upon the sands of the Inferior Oolite, including under that grouping the ironstones, or their calcareous equivalents, and the Lower Estuarine Sands. This mass of rock, thus forming an escarpment of moderate slope towards the south and west, is further eaten away by denuding agents—on the north towards Kingsthorpe, and on the east just beyond Abington—to such an extent as to form a peninsula with a connecting isthmus not much over a quarter of a mile in width. It is a peninsula of Inferior Oolite, rising out of a sea of Lias.

After luncheon, the party proceeded in carriages to carry out the programme already published.

The first group of excavations visited all lay on the north side of the town. The lowest of these is the Kingsthorpe Brick-pit, where the ferruginous beds of the Northampton Sand are seen in contact with the Upper Lias, on which they repose. This is the only one of the numerous sections hereabouts where the actual contact was observed. There seems to be a rubbly broken bed about the junction, which may be a distinct passage-bed, or merely the disturbed upper surface of the Lias Clay mixing with the Northampton Sand above. Unless there is a fresh, vertical face at some distance below the actual surface of the soil, the indications are more or less obscure. The Nursery Pit is a continuation upwards of the Northampton Sand of the last pit. The beds here are ferruginous, but chiefly calcitic sandstones, largely false-bedded, and sometimes Oolitic in texture. There are several vertical pipes to be observed—a phenomenon common enough in chalk-pits, but the peculiarity here is that the upper ferruginous beds are not attacked by the solvent, and consequently form a sort of bridge at the top of the pipes. No fossils were found in this quarry, though many hammers were brought to bear upon its layers of rock.

In the Kingsthorpe sand-pit, the white sandy Lower Estuarine was observed, with its characteristic carbonaceous bed, from which a few species of Oolitic plants have occasionally been obtained. A considerable mass of compact red sandrock was here noticed; this runs into loose white sand both above and below. Continuing to ascend, the party, on the high grounds of Kingsthorpe (Moulton Park), found the Great Oolite Limestone, and those who were intent upon fossils found these marly cream-coloured rocks much better hunting ground than the sandy, irony, and calciferous beds which go to make up the Northampton Sand of the Inferior Oolite. *Rhynchonella concinna*, *Modiola imbricata*, *Myacites calceiformis*, *Ostrea Sowerbyi*, were to be picked up in abundance. Besides these, specimens of *Clypeus Mülleri*, the characteristic *Pinna ampla*, *Myopsis dilatatus* (stunted specimen), *Isocardia tenera*, and several others, were obtained. Mr. Sharp pointed out also a hard semi-crystalline bed, crowded with *Alaria*, *Nerinæa*, *Astarte*, and other shells, but in such a matrix as to defy extraction without time and proper appliances.

Descending eastwards, the Broughton Green Quarry was visited, where, as in the Nursery Pit previously noticed, the base of the Northampton Sand appears as a limestone more or less sandy, and not obviously fossiliferous. Indeed up to this point not a fossil had been secured by any of the party from the Northampton Sand as evidence of its geological horizon. At Bass Pit, however, nearer Northampton, a single specimen of the very characteristic *Rhynchonella cynocephala* was secured. Yet, by watching carefully, Mr. Sharp has obtained from these pits and elsewhere, a large series, in species more numerous than has been obtained from the much more fossiliferous Great Oolite above.

This completed the inspection on the north side of the town, through which the party now passed out towards the west, making a pilgrimage *en passant* to the tomb of William Smith, "the Father of English Geology," who, whilst journeying to a meeting of the British Association, was in this town arrested by death, 28th August, 1839, and buried in St. Peter's churchyard.

The Duston Quarries presented the most imposing section of the ironstone series of "the Northampton Sand" visited during the excursion, having 22 feet of ironstone alone. Amongst the few fossils secured were *Pecten personatus* and *Gervillia Hartmanni;* but, as in all other quarries of this stone, there were very few to be found. Mr. Sharp's collection, however, is so rich as to supply all that is required for reading the life history of the period to which these beds must be assigned. The majority of fossils from this place occur as casts. Judging from data thus supplied, there can be very little doubt that these beds belong to the Inferior Oolite, and to the lowest zone of that formation, as might indeed have been inferred from their resting immediately on the Upper Lias clay. It is not quite clear whether the passage or *Opalinus* beds should be included; but as *Ammonites Murchisonæ* occurs tolerably high up in the ironstone, this is at least probable, and many other facts, such as the occurrence of *Rhynchonella cynocephala*, point in the same direction. *Cardium Buckmanni*, *Pholadomya fidicula*, *Ceromya Bajociana*, *Isocardia cordata*, *Terebratula ovoides* (*T. trilineata* of Young and Bird), and numerous species of *Lima* and *Cucullæa*, peculiar to the Inferior Oolite, all tend to prove the true position of the ironstone, which, indeed, could never have been assigned to any other formation if the extensive series of fossils obtained since the working of these numerous quarries had been available at an earlier period. Their resemblance in many respects to the "Dogger" of North-East Yorkshire is most remarkable, as was some time ago pointed out to Mr. Sharp by Dr. Lycett. This latter fact suggests many reflections as to the original condition and subsequent metamorphism of these very singular beds. At present the bulk of the mass consists of a yellow friable earth, partly sandy and partly Oolitic, seamed in all directions by hard bands, consisting chiefly of hydrous peroxide of iron. This, when sifted, constitutes a considerable portion of the commercial ore, and contains, perhaps, somewhat under 40 per cent. of metallic iron. About 1800 tons of it are raised weekly in the Duston Quarries. In some places there occurs a line of nodules of ferrous carbonate, and in the Duston Quarries a very striking feature is a thick band of greyish green ironstone, low down in the series, which is rejected on account of the quantity of phosphoric acid which it contains. This is, for the most part, a carbonate of iron, with, perhaps, some silicate. Such is a very brief outline of the present condition of the beds. That this condition is the result of chemical changes, occurring at more than one period in the history of these rocks, the traces of so many organic remains prove most conclusively. And here a study of the contemporary (in a geological sense) ferruginous Oolites of Yorkshire may help us much. Taking the Dogger Beds at Blue Wyke, we find an arenaceous Oolite, in which there is hardly any lime. The ova there consists almost entirely of ferrous carbonate. It might be contended by those who had visited the latter locality at Easter, those who attended both excursions had a good opportunity of comparing the two. The state of the fossils (occurring chiefly as compressed casts) is exactly the same, and altogether there is a general external resemblance, which is very striking. Moreover, in each case, fossils are very abundant, but of a somewhat different *facies*. *Gervillia acuta* occurs plentifully in each, and there is likewise here a *Trigonia* not unlike *T. impressa* of Stonesfield, but beyond this point there is not much resemblance in their respective faunas. The party collected several species here, as *Hinnites velatus*, *Pinna cuneata*, *Avicula Braamburensis*, *Ceromya sp.*, *Cardium Buckmanni*, *Cucullæa cancellata*, *Modiola Sowerbyana*, *Trigonia pullus*, *T. compta*, and, most characteristic of all, *Pteroperna Bentleyi*. Plants and some teeth and scales of fish occur; but the formation appears deficient in the remains of insects, reptiles, mammals, which are the glory of the Stonesfield beds. After a delightful drive through Ketton, and thence along the Stamford Uppingham high-road to Luffenham Station, the party took the rails once more, and arrived at Northampton at 7 P.M. Before finally separating, the thanks of the excursion party were most heartily tendered to Mr. Sharp for his hospitality on the previous evening, and for the kindness and unwearied zeal which he had exhibited during two long and arduous days.

II.—June 5, 1874.—Henry Woodward, F.R.S., President, in the Chair.—The following communications were read:—

1. "On the Lower Cretaceous Beds of Folkestone." By F. G. H. Price, Esq.

The town of Folkestone is situated upon the Folkestone-beds of the Upper Neocomian. These the author divides into four lithological groups, commencing with a sandy bed containing many phosphatic nodules, and which he considers to form the true division between the Folkestone and underlying Sandgate-beds. The *Rhynchonella sulcata* bed, an important fossiliferous zone, lies at the base of the latter.

The general character of these Folkestone-beds is that of a loose yellowish sand, parted by seams of coarse calcareous sandstone. Masses of branching sponge are especially plentiful in these rocks. The last bed of the Folkestone series is a very remarkable one, consisting of four irregular seams of large nodular masses, composed of coarse grains of quartz, glauconite, jasper, lydian stone, and phosphatic nodules. Its fossil contents occur mostly as rolled phosphatic casts. This is the zone of *Am. mammillaris*.

Four feet of loose sands succeed, capped by a line of pyritous nodules; and then occurs a seam of dark greensand, containing two lines of phosphatic nodules, largely charged with *Am. interruptus*. and other fossils in the form of rolled casts. Upon fragments of *Am. interruptus* occur *Plicatula pectenoides*, *Pecten quinquecostatus*, *Trochosmilia sulcata*, and *Nucula* sp., forms contemporaneous with the bed.

The argillaceous-beds of the Lower Gault, which succeed, are frequently very dark in colour, and more or less parted off by lines of nodules, marking certain zones of life which the author had already described in considerable detail in a recent communication to the Geological Society. They are very rich in well-preserved fossils, one bed in particular, towards the top of the group, is full of *Gasteropoda*. With two exceptions, the ammonites belong to the *Dentati* and *Tuberculati*. The thickness of this sub-formation is about 28 feet. From the grey marl or Upper Gault it is separated by a nodule or passage-bed of much importance, as this nodule-bed marks the extinction of many of the Lower Gault forms and the introduction of others.

Of 247 species, which the author had noted from the entire Gault of Folkestone, there occur 170 species in the Lower Gault, and 103 in the Upper, of which 46 species are common to both, whilst 20 species are peculiar to the passage-bed.

The base of the Upper Gault may be known by the large quantities of *Inoceramus sulcatus*. This sub-formation is characterized by ammonites of the group *Cristati*: *Brachiopoda*, not found in the Lower Gault, recur; though *Bhynchonella* is still absent. There are, in the lower beds especially, considerable traces of Chelonian and fish remains. The upper 50 feet consists of a pale grey marl, of which the portion subjected to analysis yielded 26 per cent. of lime carbonate. About 17 feet from the top occurs a seam of greensand, containing nodular bodies, having the appearance of pyriform sponges. Just below this seam the *Hylospongia* of Sollas was found. A peculiar fauna characterizes these greensands. Above them *Am. varians* first appears.

2. "On a Collection of Fossils from the Upper Greensand of Morden, Cambs." By H. George Fordham, Esq., F.G.S.

III.—Saturday, June 27th.—The whole day was devoted by the members to a trip to St. Mary's Cray, Well Hill, and Shoreham, in Kent. On arriving at St. Mary's Cray, the Thanet Sands and the lower pebbly beds in the cutting at the railway station were first inspected, and then the valley deposits close to the gas-works, consisting of ten or twelve feet of fine loamy brick-earth with land-shells and a little gravel, the chalk being seen below. Professor M'Kewan Hughes, who was with the party, gave an interesting field lecture on the valley and its surroundings. Skid Hill, distant four miles, was then visited, and here Mr. Prestwich, F.R.S., who had walked from Shoreham, met the company, and acted as conductor for the day. Skid Hill, which commands good views of the long dry valley of the Upper Cray, is capped with flint gravel. It is a portion of the interesting outlier of Thanet Sand and Woolwich Clay, which at Well Hill—a mile further along the same elevation—has a still larger deposit of flint gravel, of great age and singular interest. Indeed, Well Hill was the central point of interest for the day. Have we here, in Kent, a true glacial gravel? Such was the question, to which, as will be seen, the leader of the party gave no hesitating answer. The spot where the gravel sections were reached is more than 600 feet above Ordnance datum. Here, overlying the Woolwich beds, were large rolled flints, remarkably fossiliferous, in a reddish sandy matrix, without any stratification. A closer search, at the suggestion of Mr. Prestwich, discovered fragments of chert and ragstone. These Mr. Prestwich refers to the Lower Greensand beds of the Sevenoaks range, some six miles further south, now separated by the deep and bread valley of Holmsdale. The Well Hill gravel, according to Mr. Prestwich, is a solitary patch of *marine gravel* of glacial age, which once stretched over

Kent, and is altogether an unique geological memento in the county. On leaving Well Hill, the excursionists felt they had seen the great sight of the day. At Shoreham the conductor pointed out some notable sand-pipes in the chalk by the side of the high road to Sevenoaks, between the eighteenth and nineteenth milestones; a very fossiliferous bed of chalk with *Inoceramus* near the first shaft at the north entrance to Halstead tunnel, and a dry upper valley of the chalk (south branch of the Timberden Valley) with six feet thickness or more of flints, the water standing at a level below the valley fully 100 feet deeper than it once stood; and, lastly, the trumpet-mouthed valley of the Darent, opening out into the Weald, but draining in the opposite direction into the Thames. The party, numbering between 40 and 50, were subsequently entertained by Mr. and Mrs. Prestwich at their mansion, Darent Hulme, where a cordial vote of thanks was presented to the conductor through Mr. Henry Walker and Professor Hughes.

IV.—July 3rd.—Henry Woodward, F.R.S., President, in the Chair.

1. "On the Deposits now Forming in British Seas." By G. A. Lebour, F.G.S., etc.

The author limited his present task to a brief description of the principal constituents of British Sea Bottoms, with particular reference to their distribution and its causes. The materials are of *mechanical*, *chemical*, or *organic* origin. The agencies by which these three kinds of sediment are distributed include rain, rivers, winds, tides, currents, and the composition of sea water, but all are subordinate to the configuration of the sea floor. The area under consideration is situated on the westernmost margin of the Old World plateau.

Rock Bottoms.—In some places no deposit occurs, the bare rock being left. The largest of these bare spots, in British seas, occurs in the western half of the Channel valley. Their distribution is directly connected with that of currents, and this is strikingly proved by their being limited to no relative depth; for, in the Channel, their range extends entirely across the valley, and reaches in one place, north-west of Alderney, a depth of more than 86 fathoms at the deeper end of a curious longitudinal oblique depression, called by M. Delesse the *fosse centrale* of the Channel. Another bare area exists at the point where the Atlantic cable enters the yet deeper region of the Atlantic ooze, in 500 fathoms water. The specimens brought up by the sounding instruments from such places consist of weathered and rotten stone, pointing to chemical rather than mechanical disintegration, even where powerful currents are present.

Marine Deposits.—These consist chiefly of sand, with occasional islands of clay, mud, gravel, and shell detritus. The broader the sea, the greater the proportion of sand: thus the North Sea bottom is especially a sandy one, though towards the centre the sand becomes muddy over a considerable region. Sandy bottoms also largely prevail in the north-western seas, and on the west coast of Ireland; but [illegible]th of Ireland a large expanse of fine mud and muddy sand [illegible]s in a south-easterly direction. As submarine deposits, gravels are rare, the largest bed of this sort lying between Havre and Calais; they appear almost entirely confined to the Channel, and may in some cases be due to the degradation of marine outcrops *in sitû,* though most of them are the result of transport from our shore pebble-reaches. Where a clay bottom is indicated, its origin also is in some cases doubtful.

Organic Deposits.—In the Channel the shell deposits attain their greatest development as regards British Seas. Here they follow two long, occasionally broken lines, following at a short distançe the English and French shores, and forming at the outer mouth of the Channel a vast shell-bank. These deposits actually cross the broad sea valley, partly over and considerably to the west of the spread of bare rock previously mentioned. Elsewhere in the Channel the Gallic side is richer than the English. There are other shell deposits around our coasts, but of less importance. Beyond the ocean valley which lies beyond the Hebrides and the Rock-ball reef, there occurs a fish bank more than three miles in length, affording us an inkling of the manner in which some of our fossil fish beds may originally have been accumulated.

Fluvio-marine Deposits.—The Thames, Seine, and Tay form mud banks in a sandy sea. The sub-marine delta of the former has the shape of a triangle, of which the apex points seawards; that of the Seine is also triangular in outline, but the apex points landwards. Such sub-marine deltas can only be recognized when the materials of which they consist are distinct from those forming the prevailing sea-bottom.

The question of *shore deposits* was merely alluded to, this subject forming no part of the present paper. Of true *chemical* deposits it cannot be said that the comparatively shallow seas of Britain offer any good example.

Although much of the above materials are at present unconsolidated, especially the sands, it is not probable that the larger features of the sea bottoms are liable to important changes, whilst the surrounding geographical conditions remain unaltered. The same agencies which sweep certain spots bare, heap up material elsewhere, and the relative form of both covered and uncovered portions of the sea floor is preserved by them. The points of the greatest violence of current action are shown by the bare rock patches, whilst the intermediate stages of agitation are represented by coarse shingle, sandy gravel, sand, muddy sand, and finally patches of mud or clay supervene, which to a certain extent indicate centres of calm.

2. "On some Specimens of Phosphorite from the Department of the Lot." By F. W. Rudler, F.G.S.

3. "On a Probable Solution of Mr. Charlesworth's Problem relative to the Boring of Sharks' Teeth." By H. A. Burrows.

This perforation was connected with the existence of the foramen for the passage of blood vessels, opposite to which are numerous small holes, as observed to exist in the teeth of recent sharks.

CORRESPONDENCE.

MR. SCROPE'S VIEWS OF VOLCANIC HEAT.[1]

SIR,—My objection to Mr. Scrope's notion of the source of volcanic heat, as enunciated by him in the GEOLOGICAL MAGAZINE for August. page 344, viz. that "volcanic heat is derived chiefly and directly by conduction or convection, or both, from that intensely heated interior mass of the globe," which he says, but erroneously, is necessary to my views, is not so easily set aside as Mr. Scrope would have to be believed by the above article. My objection is that this vague notion involves in reality a thin crust and liquid nucleus which Mr. Scrope professes to repudiate, and he rejoins that, with unpardonable ignorance, I have assumed that the liquefied matter filling his reservoirs and the material of the nucleus have the same melting point.

My objection does not involve any such assumption, and is equally valid, though the melting point of the nucleus be assumed much above that of the matter filling these reservoirs. What does Mr. Scrope *know* of the material constituting the deeper portions of our globe or of their fusibility. The only ground for conjecture even as to the latter is derivable from protruded granites, porphyries, elvans, traps, or other ancient fissure-extruded matter, none of which differ greatly in fusibility from modern lavas. But if we assume *argumenti gratiâ* that the material of the nucleus at a still greater depth than is indicated by these is fusible only at a temperature twice or thrice that of fused lava, the physical conditions under which alone heat could be conducted from the nucleus to one of these reservoirs through some hundreds of miles of intervening rocky matter, are sufficient to prove that if the lava in the reservoir be thus brought into fusion, the temperature of the nucleus must be so vastly higher that its material, if like anything we are acquainted with, must be in fusion likewise. Is Mr. Scrope aware that, apart from all question of imperfect conductivity, matter heated by conduction from the central parts of a globe decreases in temperature faster than the inverse square of the radial distance from the centre? If the heat be transmitted by convection or in vapour, there must be liquid or gaseous connexion between the nucleus and the reservoir, for without such, convection is impossible. Thus two of Mr. Scrope's alternatives directly involve fluidity in the nucleus; solids do not pass into the state of vapour except through the intermediate stage of liquidity. Thus I reiterate that this notion of reservoirs of matter melted by heat transferred from more highly heated matter, situated at a much greater depth, by conduction or by convection through gaseous or liquid matter, or by both, is only the old notion of a thin crust and liquid nucleus in disguise, and if that be, so *cadit quæstio* as to my having misrepresented Mr. Scrope's views. His views are by his own statement (GEOL. MAG. May, page 237–8) entirely different from mine, and it is wholly unimportant to my views what his may be. I have already declined, for want of definition, further discussion as to the nature and origin of volcanic heat. I now decline further discussion as to the charge of misrepresentation. I can afford to leave that, as well as the truth of my own views, to "time, the revealer."

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[1] [illegible]This letter is inserted at Mr. R. Mallet's earnest request. But it is hoped that [illegible]ussion will now be allowed to terminate.—EDIT. GEOL. MAG.

LONDON, *24th August*, 1874. ROBERT MALLET.

ON THE ANTIQUITY OF THE WORKED FLINT FROM THE BRICK-EARTH OF CRAYFORD.

I am not surprised that a doubt should be thrown upon the antiquity of the worked flint, which I found at Crayford in 1872.[1] It usually happens so when anything unexpected is discovered. It appears to me, however, that there is but one escape from the admission that the implement is as old as the Thames valley brick-earth, and that is to show that the entire deposit at Slades-green pit at Crayford is re-assorted. The lines of bedding there are continuous along the pit, and it was from one of these, about twelve feet from the surface and six from the floor of the pit, that the flake was extracted. It was a layer of rounded pebbles, about five inches deep, lying below the band with *Cyrena trigonula,* and above the bone bed.

I was struck by seeing the edge of a flat piece of flint protruding from a layer of rounded pebbles, and therefore picked it out and found it to be a "scraper." I instantly called Mr. Dawkins's attention to it, and pointed out the hole I had made in extracting it. He said, "Show it to Mr. Evans." I did so the next day, and Mr. Evans pronounced it undoubtedly a worked flint. In the note (p. 391) where this find is referred to, Mr. Woodward also quotes Mr. Boyd Dawkins's published mention of it, and then adds: "These may, however, and probably did, belong to a later date," etc. I do not understand why he says "these," for only *one* was found.

O. FISHER.

GYROGONITES, ETC., IN THE LONDON CLAY.

SIR,—Believing that *Gyrogonites* (fossil seed-vessels of *Chara*) have not been hitherto noticed in the London Clay, I beg to mention that Mr. Joseph Wright, F.G.S., of Belfast, has lately favoured me with some specimens found in the London Clay of Copenhagen Fields, Islington, by Mr. John Purdue, when the Great Northern Railway cuttings were being made. These *Gyrogonites*, obtained by washing the clay, were associated with thousands of Foraminifera and many Entomostraca (see *Geologist*, vol. vii. p. 85; Monogr. Tert. Entom., Pal. Soc. p. viii). They are referable to two species: one is dark brown, ovoidal, and like *Chara helicteres*, Brongniart, as figured in the Memoirs Geol. Surv. Gt. Britain, Isle of Wight, etc., 1856, pl. 7, figs. 3, 4, but relatively longer; the other is light brown, spherical, and like *Chara Lyellii*, ibid. fig. 7, but rather more globular. There are five or six specimens of each species.

From the same source, and by the kindness also of Mr. Wright, I have *Cythere plicata*, Münster, to add to the known fauna of the London Clay.

September 26, 1874. T. RUPERT JONES.

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[1] GEOL. MAG. Dec. II. Vol. I. p. 391.

NEW LOCALITY FOR *LEAIA*.

Sir,—Mr. J. W. Kirkby, of Pirnie Colliery, near Leven, Fife, has kindly sent me a piece of ironstone, containing casts of two valves (perhaps a pair) of *Leaia* (spec. indet.), from the spoil of an old ironstone pit, north of Wemyss, Fifeshire, and informs me that its geological position is in the lower part of the Coal-measures. This, then, is a new locality for the interesting genus *Leaia*. See Geol. Mag., Vol. VII. p. 219; and Vol. VIII. p. 98.

September 22, 1874. T. Rupert Jones.

RHÆTIC BEDS NEAR NEWARK.

Sir,—In the Geological Magazine for July, 1874 (p. 318), the Rev. A. Irving points out the occurrence of the Rhætic beds at Newark, and makes a few remarks upon the White Lias, which is not seen *in situ*, although what appear to be fragments of it are found in the soil above.[1]

While engaged in the spring-time of last year in tracing out the Rhætic beds near Newark, I was (owing to the absence of sections) for some time at a loss to fix the boundary line between these beds and the Lower Lias above. The lower members of the Rhætic beds, as Mr. Irving describes them, are well shown in the plaster-pits above Newark, and consist of the black paper-shales and greenish-yellow marls, resting upon the red and mottled gypseous marls of the Keuper.

An examination in company with my colleague Mr. W. H. Holloway, of the excellent section near Barrow-on-Soar, showed that above the black shales there was a considerable thickness of apparently unfossiliferous grey earthy marl, capped by a hard bed, which I took to represent the upper limit of the Rhætic formation. Above it the ordinary Lower Lias limestones and clays come on.

Subsequently Mr. Holloway and myself had a Lias quarry on the Coddington road, near Newark, deepened, and at the base of the Lower Lias series there was exposed a hard compact homogeneous limestone, in texture not unlike the "Sun-bed" of the West of England. This bed was much water-worn, and owing to the action of the water sustained by clayey beds beneath it: such was its power, indeed, that the bed was worn into fantastic shapes, well justifying the quarrymen's term of "Flints." This bed of "Flints" is no doubt homotaxeous with the hard bed in the Barrow section, and the clayey beds beneath may similarly be identified with the earthy marls of the same section, although in the Newark country the rarity of pits and exposures and the great deposits of drift preclude its being observed.

The total thickness of the Rhætic beds at Newark, according to measurements and estimates by Mr. Holloway and myself, is about 60 feet. Further details on the subject, however, must be reserved for the Survey publications.

Mount Pleasant, Newton Abbot, Horace B. Woodward.
23rd September, 1874.

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[1] Mr. F. M. Burton has noticed the similar occurrence of fragments of White Lias in the section at Lea, near Gainsborough (Quart. Journ. Geol. Soc. 1867, p. 315).

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ORIGINAL ARTICLES.

POPULAR PAPERS ON GEOLOGY.—No. 1.

I.—A Ramble across the Mendip Hills.

By Horace B. Woodward, F.G.S.

MANY of those interested in geology are by time generally forbidden, and perhaps by inclination equally restricted from the investigation of details on a holiday trip. Nor need this be regretted, for the greatest pleasure in science is not always to be gained by the examination of details, but rather in the contemplation of results derived from such an examination.

Actuated with this idea, I propose taking my readers on a trip across the Mendip Hills, and to point out some of the many scenes of geological interest and also of beauty to be met with on the way. Somersetshire abounds with beautiful scenery, and is noted as much for its great variety in this respect, as for the number of geological formations represented in it; and which combine to form its cliffs and ravines, its escarpments, table-lands and broad fertile vales. To those who are satisfied with the moderate elevation of a thousand or fifteen hundred feet, a few weeks in the "pleasant country" of Somerset will furnish many a delightful ramble.

We shall make our first journey to Bath, which by a fast train from London is reached in about three hours. It is a town well calculated to charm, from its beautiful situation and well-built stone houses, while its fine old Abbey Church furnishes a grand example of the Perpendicular style of architecture. The mineral waters of course are the principal attraction—to them Bath owes its origin. When the Romans first came to the spot, as Sir Charles Lyell tells us, it was lonely and desert, there was no doubt a large morass from which clouds of white vapour arose; but the invaders soon found out the sanitary properties of the water, and built their spacious bath-room in a highly ornamental style of architecture, decorated with columns, pilasters, and tessellated pavements, remains of which have been discovered during modern excavations. One thing that will strike you is, Whence come these waters? They are the hottest in England, their average temperature being about 120° Fahr., and they contain several salts, such as lime, soda, and magnesia. No doubt they rise from a great depth, and Sir Charles Lyell is of opinion that they mark the site of some great convulsion and fracture, which took place in the crust of the earth at some former period—perhaps not a very remote one, geologically speaking—so that they may be looked upon as a sort of volcanic eruption, although unaccompanied by the ejection of lava and ashes, which render active volcanos such undesirable neighbours.

We must not omit to have a look at the Museum of the Bath Literary Institution, where a grand series of fossils has been deposited by Mr. Charles Moore, F.G.S. On the walls we see specimens of those large reptiles which flourished in the Liassic period: the *Ichthyosaurus* and the long-necked *Plesiosaurus*, forms which you may see restored in the gardens of the Crystal Palace, and whose fossil remains have been found in such abundance in the famous quarries at Street, near Glastonbury. The collection is particularly interesting, as being mainly a local one, and most of the specimens were obtained by Mr. Moore himself. Not the least interesting is a tray containing about 70,000 minute fish remains, collected from a vein in the Mountain Limestone at Holwell, near Frome; also the cuttle-bones from the Upper Lias near Ilminster, with the ink-bags which still retain the remains of their once fluid ink (sepia).[1]

Leaving Bath, we will proceed along the Upper Bristol-road, which leads to New Bridge, taking a last peep at the grand river-valley, which, higher up, between Bathampton and Freshford, is very picturesque; where the hill-sides are well-wooded, and here and there studded with fir-trees. The Great Oolite, or Bath stone, is quarried on the summits of these hills;—the excavations would well repay a visit—the stone is often regularly mined, and it is easily worked out, as it is comparatively soft before it is exposed to the atmosphere, when it hardens and forms capital building stone. When we examine it closely, we find it composed of a number of small round grains, like the roe of a fish; whence originated its name of Oolite, or roe-stone. In the valley we find patches of gravel; these have yielded the remains of animals which, in comparatively recent times, inhabited the country; such as the elephant, rhinoceros, wild boar, and musk ox or arctic buffalo.

Gravel has been dug in the park opposite the Royal Crescent, and there a fine tusk of the mammoth, or elephant, was noticed not long ago by the Rev. H. H. Winwood, F.G.S.

In the cutting near the Weston station, on the new Midland Railway, we find a very interesting section of the Lower Lias limestones; and beneath them, of the White Lias (Rhætic beds), containing at its base the well-known Cotham, or Landscape marble, of which polished slabs are so often seen on our mantel-pieces.

After crossing the river near Twerton, we come soon upon some Lias quarries which yield famous Ammonites, a foot and eighteen inches in diameter. This species is named after Dr. Buckland, of whom it is told, that having one day obtained a large specimen which had lost its inner whorls, he placed it over his head and shoulders, and so rode home, dubbed by his friends the "Ammon Knight."[1]

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[1] *In the Museum of the Geological Society of London there is a painting executed in fossil sepia.*

There also is a coal-mine; but as we are going to look at those at Radstock, we shall not delay here, but push on now through Marksbury, with Stantonbury Hill Camp on our left. Near here are traces of the Wansdyke, which is considered to have been the last frontier boundary, or line of protection, of the Belgæ, as they drove the ancient Britons northwards; and the numerous old camps speak of the hard struggles between these tribes and the Romans who followed.

Thence we pass over a gentle hilly country, which has a certain sameness about it, to Radstock. This may be said to be the capital of the Somerset Coal-field, although it is a miserable little town. One of the most striking features in the neighbourhood is the number and size of the coal tips, the heaps of shale and grit brought up from the mines and tipped at the mouth. They form large hills, and quite alter the appearance of the country around Radstock, Camerton, Timsbury, and Paulton. The reason why the mines are usually commenced some little way up the hills is to allow for these tips. Wishing to go down one of the mines in company with a friend, we arranged with the steward, or overseer of the men who worked in the mine, and then awaited our turn to descend the shaft into the lower regions. It was a busy scene above ground, the coal being brought up and carried away in little trucks, to be transferred to the railway waggons close at hand, or to be conveyed away in carts to neighbouring towns. Boys and men were hard at work performing various duties, some at the engine-house, where a stationary engine was placed to draw up and let down the little trucks that carried the coal out of the mine. In some of the mines changes of clothes are provided for visitors. I inquired of a coal-miner as to this, whereupon he took off his old cap and offered it to me. Under the circumstances, I preferred adhering to my own.

When all was ready, we got into a sort of iron cage with a lot of men. "Keep still, and don't put your arms out," were the words of caution given, and down we went some seven hundred feet with a swift but steady movement into the mine. We felt the air at once close and oppressive. When at the bottom, we were provided with candles, as in the Radstock mines there is no danger from "fire-damp." Our guide proceeded with a flaring oil-lamp, leaving behind it an odour that was anything but refreshing. We walked cautiously along a tramway, having every now and then to stand up close to allow a truck to pass, which was pulled along by a wire rope, and we had to be very wary of this rope, which lay along our track ready to be pulled away at a swift pace at any moment. Further in the mine the way got shallower, and we had to stoop; horses were employed in drawing the trucks, and galloped along attended by small boys. The passages which at first were bricked up were now supported by beams of wood, for as the coal is worked out, so they have to continue supporting the roof by stout blocks of wood, lest the whole series above should give way. As we went further into the mine, passages branched out in all directions, so that a stranger might easily lose himself in it; the way got still shallower, and we had to stoop more; "heads" was frequently called, as a thick beam projected from the roof, and we had to bend down very low; ponies were employed, as horses could not enter, and the poor animals got many a knock on the head, and grazed their backs, which all the time had a "close shave" with the roof. At last we got to the place where the men were at work, and we had to crawl into a hole to see them. They were lying on their sides, not too profusely clothed, and pecked away at the coal, which was shovelled into a truck by another man, and drawn away by a pony in charge of a boy. The men carried their candles in little tin holders attached to their caps. After all, there is very little to be seen in a coal-mine, there is so much coal-dust concealing and coating everything; while the closeness of the atmosphere, and having to stoop the greater part of the time, render the change, when you reach the exterior and are in fresh air again, a truly grateful one.

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[1] See Notes on a Geological Excursion to Bath, by Prof. Morris, Geol. Mag., Vol. V. *p. 234.*

The veins worked at Radstock are very thin, the thickest being two feet four inches; to the south in the Vobster series there is a vein of shaly coal eight feet in thickness; these are very small compared to the seams in the North of England, where in the Dudley Coal-field there is one thirty feet in thickness! The coal is mostly adapted for household purposes, and is largely burnt in the Western Counties, but it is not very first-rate, as it leaves a great deal of ash.

Although the Radstock Mines are free from fire-damp, this is not the case with some at Newbury, Vobster, and Edford, nearer to the Mendips, where the seams are much disturbed. Some fiery veins occur at these places, and some explosions have taken place, so that it is necessary to use the Davy lamp. The depth of the mines varies; that at Braysdown near Radstock, 580 yards, is the deepest.

If you spend a short time in examining the heaps of shale thrown out from the mines, you may find many ferns and other plant-remains for which the Radstock district is noted, particularly those called *Pecopteris*, *Neuropteris*, *Calamites*, *Lepidodendron*, *Sigillaria*, and *Asterophyllites*, also perhaps a few bivalved Mollusca or Crustacea, which tell us of the life which existed during the Coal-period. We must go a very long way back in time to restore the physical geography of the area during the formation of the coal. We must picture part of a land-locked sea into which several rivers flowed, bringing sedimentary matter, sand and mud, and depositing it at the sea-bottom. The water could not be very deep, for soon either the increase of sediment or a slight elevation produced a land area upon which grew a luxuriant vegetation, which in process of time was submerged, and covered up by fresh sedimentary material. This buried mass of vegetation is now our coal. The coal occurs in seams, alternating with shale, clay, and sandstone, showing that there was a constant change of conditions from a land area producing vegetation, to a water area allowing the deposition of sediment; such a repetition brought about the series of rocks we now call the Coal-measures, and which in Somersetshire attains a thickness of about 8000 feet.[1] In this great thickness of shales and sandstones there is only about 100 feet of coal. It has been worked with more or less activity for the last four hundred years, and yet at the present rate of working it is calculated that we have enough to last two or three thousand years, and the total amount available to the depth of 4000 feet in the Bristol and Somerset coal-fields is estimated by the Coal Commissioners as equal to a supply for 4219 years. This refers only to the West of England. Taking the whole of the British coal-fields into account, the supply is considered as only equal to about three centuries. There is still plenty to last us, although we have to pay rather dearly for it now.

Leaving Radstock, we may proceed to Chewton Mendip, which is pleasantly situated on the borders of the Mendip Hills. The walks in the neighbourhood are pretty and varied—to the east are many combes in the Mountain Limestone, while to the west we find a flat of Lias, and at Emborrow a picturesque little lake bordered by woodland, which is situated in the oldest rocks of the Mendips—the Old Red Sandstone and the shales above it. In the walls near Chewton Mendip we find many ferns, the Brittle bladder fern (*Cystopteris fragilis*), the Ceterach, the Black spleenwort (*Asplenium adiantum-nigrum*), the Wall-rue (*Asplenium Ruta-muraria*), Maiden-hair (*Asplenium trichomanes*), and other common ferns.

In taking the road which winds its way gradually up-hill to Priddy by Egar Hill, we have a first peep over the wild-looking country of the Mendips. Near Tar Hall we find some old lead-washings, then the road is bounded on the right by a picturesque wood, and above the hill on the left an open barren land stretches away for some distance. At the cross roads by Egar Hill all looks bleak and barren, and here we find ourselves getting into a country which has been largely worked for metals. The whole surface of the ground about this neighbourhood has been dug and quarried. We cannot see very much now, but there are indications that here and there a mineral vein was followed.

Near Priddy are some groups of barrows, or sepulchral mounds, one of nine, the other of eight, in number. They usually contain a small circular hole filled with burnt bones, cinerary urns, and sometimes also beads.

At Stoney Littleton, near Radstock, a barrow was opened some years ago. It was 107 feet long, 54 feet wide, and 13 feet high; and was found to contain a long gallery, with chambers on each side, whose walls were built of thin layers and slabs of stone without cement, forming in fact regular Cromlechs. Although it had been previously disturbed, one of the recesses contained an earthen vessel containing burnt bones. The mound or barrow was formed, not as usual of fine mould, but of small stones, probably a rubble of Inferior Oolite.

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[1] *See Lecture on Coal by* A. H. Green.

Mr. Thomas Wright, F.S.A., remarks that the only monuments to which people in a rude state of civilization seem to have been anxious to give durability were their graves, and in the greater number of cases the barrows and cromlechs were placed on lofty hills, commanding extensive views of the sea, if on the coast; or when inland, of the surrounding country, as it seemed to have been the desire of the chiefs to be buried in such commanding positions.

At Stanton Drew some interesting Druidical circles are to be seen in fields to the east and south of the church. There are traces of three circles, indicated by huge stones, the largest is about nine feet in height, and the largest circle, or rather ellipse, measures 126 yards by 115 yards; fourteen stones remain in it.

The Mendip mines have been worked from very early times. The district was occupied by the Belgæ, and, subsequently the Romans, probably tempted by the rich mines, made it one of their first points of occupation. In the time of Edward IV. it is said that these mines furnished employment to 10,000 miners, and the immense deposits of slags and slimes indicate the extent of the workings. Galena (sulphide of lead) and Calamine (carbonate of zinc) are the ores which have been principally worked. There is a good deal of iron-ore also. A common way of discovering a lode or mineral vein was to dig a trench until one was met with. Another plan, and one that, strange to say, even now appears to be practised, was to use the divining-rod. This consisted of a forked hazel twig, which we are told "if properly held by a person with whom it will answer," will indicate any metal, coal, or a spring of water! The virtue of divining is confined also to few persons. The receipt is, "Go to a hedge, and cut from it a forked twig of hazel or white thorn, of one or two years' growth, cut off the small sprouts, then place the end of each fork between the second and third fingers of each hand, and apply your hands closely to each side of the body, just below the short ribs; keep the rod in a horizontal position, and walk slowly over the ground. If you possess the power, when you arrive over the hidden object of search, the fork will either be repelled with force back against the chest, or attracted downwards to the earth." It is strange, indeed, that such superstition should even now invest the minds of some people!

Leaving the Priddy mines, we proceed northwards by the "Castle of Comfort" (not at all a comforting old inn), and turn off from the main road down Lamb's Bottom, a narrow defile formed in the Mountain Limestone, which juts out from the cliffs in bosses and peaks with now and then a hollow with a clear spring gushing out, and beautiful specimens of *Cystopteris*, wall-rue, ceterach, common Maiden-hair, and other ferns lining the interior of the miniature cavern. There was formerly a large cavern accessible by a shaft seventy fathoms deep; several large vaults were thus reached which contained many stalactites. Nothing is now to be seen or heard of this cavern. The scenery in this neighbourhood reminds one of many parts of Cornwall, especially near the Cheesewring, where the umit of the hills is wild and open, with scarcely a house in view, and one or two chimneys of lead-mines are seen in the distance. A barren country it is, covered with short dry grass, few trees, and with the rocks cropping out here and there at the surface.

The Mendips are largely devoted to sheep-walks. Billingsley speaks of the breed as a sort that will thrive on the poorest soil, and fatten on such land as will scarcely keep other sorts alive.

Turning towards East Harptree we come to Noah's Ark, or rather an old house so called. Above this point are some more lead works, and here, among the old refuse heaps, we found, besides bits of galena, some interesting old pipes, some of the earliest forms (17th century), with small bowls, and the initials of the maker stamped on the nob projecting from beneath the bowl. We follow the stream from Noah's Ark along a narrow rocky gorge called Haydon's Gully, wooded on its summits. The rock here is the Dolomitic Conglomerate, a pebbly deposit, in fact an old sea-beach cemented together with iron and lime and magnesia.

Reaching West Harptree and taking the road which skirts the Mendip Hills, which are here thickly planted with trees, we pass through the little villages of Compton Martin, Ubley, and Blagdon; thence we plunge down-hill between wooded heights to Burrington.

Burrington Combe, which runs up the Mountain Limestone south of the village, is a romantic walk: the steep craggy cliffs among which the road winds give a wild appearance to the scene. There is a cavern here which has yielded many remains of the old animals which have elsewhere been found in the gravels, and which formerly inhabited the country.

Leaving Burrington, we push on to Churchill, where a rare mineral called Mendipite (an oxy-chloride of lead) has been found: we were not so fortunate as to obtain any specimens of it. Above this is Dolberry, another old camp. Mr. Ussher and myself found a few flint flakes there, and our friend Mr. A. Gillett has found some flint arrow-heads. He showed us some also from the hill above Bathford.

I well remember a journey I took from Bristol to Cheddar before the railway was made, when I passed along this road by Dolberry. I tried the carrier. The distance by the road is not quite twenty miles; we started at one o'clock in the afternoon, and reached our destination a little after nine. It would have been a delightful ride, its very slowness would have enabled one to enjoy the beautiful scenery, had not the scenes where we dwelt longest been the little road-side beer-houses. After crossing the table-land of Broadfield Down, with the famous Cleeve and Brockley Combes to the right, and the fine old church of Wrington at the foot of the hill, we crossed the vale of red marl, and then entered the Mendip Hills at a gap between Dolberry Camp and Sandford Hill. The road winds up a stiff hill with the high ground on either side, and a ravine on one side separating it from Dolberry. The wind then, it was towards the end of November, swept with great force down this gorge.

A few miles to the right is Banwell, celebrated for its caves—

the largest is, I believe, not shown to visitors. I went over one, but there was very little to see in it, no stalactites, and merely piles of old bones, which had been collected together by Mr. Beard.

To the left are the villages of Rowberrow and Shipham, where some of the most active lead and zinc workings have been carried on. About a century ago there were upwards of a hundred mines being worked at Shipham; many of these, it is said, were in the street, some in the yards, and a few even in the houses! Most of the zinc has been worked out, and, indeed, all over the Mendip Hills the surface has been tolerably well explored. It remains to be proved whether deeper mining will be profitable.

Let us now gain the summit of the hill, between Shutshelve and Wavering Down, and have a peep over the country to the south of the Mendips, a broad tract of Alluvium and moor-land for some distance, but very diversified further south, and with plenty to interest one.

It is worth while ascending to the summit of Crook Peak or Black-down, which is the highest point of the Mendips, about 1092 feet, in order to obtain the splendid view over the country which they afford. To the north Dundry Hill and the Oolitic escarpment near Bath bound the view; to the west we peep over the Bristol Channel, and we can just distinguish the dim outline of the Glamorganshire coast; while southwards we overlook the plains of Sedgemoor, with the conical Tor of Glastonbury, and the equally conspicuous Knoll of Brent. In the distance across Bridgewater Bay we may see the Quantock Hills, and further east the outline of the Black Down hills of Devonshire.

Here we descend the hills, and skirt along their base through the little market town of Axbridge to Cheddar, and then make our way towards the cliffs, which look like a great rent in the Mendip range. The best way to view the cliffs is to drive from Wells by way of Priddy, and then to enter them gradually from their weakest point on the summit of the hills; thence they become grander and grander, until they abruptly terminate, and we enter upon the moors. As we proceed along the carriage road, which winds along the gorge, we find the cliffs on our left far more abrupt than those on our right, which rise more gradually, and are often obscured by a great talus of fallen fragments. On the left the cliffs are very grand, and imposing. The "Wind Rock" is 480 feet, and the "High Rock" 345 feet. They are often perpendicular, and even overhanging, now appearing like "bold pinnacles," then as "shattered battlements," with here and there a yew tree, and the bare rocks, diversified in many places by shrubs and mantles of ivy. In winter time the path is rendered very dangerous from the masses of rock which frequently fall into the road, dislodged by the action of frost.

These cliffs are no doubt formed by the agency of rain and streams, with both chemical and mechanical action. The dip of the limestone, which is on the abrupt side away from the cliffs, and on pposite sloping side towards them, has no doubt greatly inced their formation, as in the one case it would exercise a con- tive agency, and in the other assist the removal of the strata.[1]

aving Cheddar, we pass near to Draycot, a village famous for its , the Dolomitic Conglomerate, which is now largely used in ling (as in the railway arches of the Cheddar valley line), also ate posts, etc. We here pass remnants of the old forest of lip, which in ancient times was well stocked with deer.

mersetshire at one time had four other great forests—that of ood, near Frome; Neroche, near Ilminster; North Petherton, Bridgewater; and Exmoor, on the borders of West Somerset Devon. Of the first three little else but the name remains. xmoor the deer is still hunted.

e now arrive at Wookey Hole, one of the largest caverns in and, being only second to one at Castleton, in Derbyshire. ed it is only its size that renders it worth a visit; there are no ctites to see, as in the beautiful cavern of Cheddar. Wookey is one of the sources of the Axe, which flows by Axbridge. waters contain many frogs and also eels.

ar to Wookey Hole is the famous bone cavern described by Boyd Dawkins, which contained remains of the Mammalia which ited the district in Post-Tertiary times. The Mendip Caverns yielded bones and teeth of Elephant, Rhinoceros, Tiger, Hyæna, , Wild Boar, Horse, Ox, Deer, and Hare.

e Ebber rocks, a ravine in the Mountain Limestone near key, are well worth a visit, as they are very picturesque, although o grand as Cheddar.

ells has certainly many charms, for the scenery is very fine; the Cathedral and the fine perpendicular tower of St. Cuthbert's attract the attention of all visitors. It is within an easy distance lastonbury, to which we now direct our attention.

l know the tradition of Joseph of Arimathæa and eleven others, sailed to Britain, and after travelling for many a day through ny forests and boggy swamps, at last reached the point now d Weary-all-Hill, and there, overcome with fatigue, Joseph his staff—his apostolic rod—in the earth, which forthwith ed, blossomed, and filled the air with sweet odours. Shortly wards, so the tale runs, according to the Rev. J. Williamson, erected a chapel in honour of the Virgin Mary. This they of twisted alder, and formed the lowly roof of rushes from the unding morass. More substantial buildings followed in early sh and Saxon times, where the first Abbot presided A.D. 415. ese, however, no trace remains. On the same site was erected great Abbey, whose ruined nave we now look upon; whose ept, choir, and the adjoining chapels can be traced out from the nentary arches and profusely sculptured pillars, which yet still in imposing grandeur, and whose beautiful chapel, dedicated . Joseph, is the most perfect portion that is left to us. Com- ed in the east, in a transition Norman style, in the twelfth ry, it was carried on towards the west in the same style until the west front, and a portion of St. Joseph's chapel, in connexion with it, were constructed in the Early English style.

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[1] *See H. B. W., Proc.* Somerset Arch. and Nat. Hist. Soc., 1874.

For nearly eleven centuries the devotees of all nations, to quote Mr. O. T. Hill, flocked in crowds to its fane, to worship at its altars, to adore its relics, to drink in health at its sacred well, and to gaze in wrapt wonder at its holy thorn. In the early part of the 16th century the Abbey was in the plenitude of its magnificence and power. In a few years more the last Abbot Whiting died—hanged and quartered in the reign of Henry VIII., November 14th, 1539. Its lands found their way principally into the possession of the Duke of Somerset, the buildings fell into ruin, and the magnificent library was scattered. So great has been the neglect of the place that until the present owner, James Austen, Esq., purchased the Abbey estate, it was left entirely to nature, except when blocks of fallen stone were taken away as material for mending roads. We may be thankful that the ruins are well taken care of now, though we may smile when we reflect that where was once all the splendour of England's greatest Abbey, now there is a croquet-lawn!

Before leaving, let us look at the Abbey kitchen, which contains four large fire-hearths, each sufficient to roast an ox in.

It is a good pull up the Tor, and we wonder how the people went to church on a hot summer's day; however, there is not much inducement to do so now, for though they have been there, they cannot go more, as the body of the church was overthrown by an earthquake in 1275. The most remarkable circumstance, however, was that the tower survived the shock, and there it still remains, as a monument of a people with rather elevated ideas.

The Tor may be looked upon as an island in the geological sense, it is an outlier of the Sands which occur between the Lias and Inferior Oolite; there is no hard capping to protect it, and so it is a remarkable instance of isolated denudation. Brent Knoll is another. However, while we are at the Tor, we may collect many Ammonites rom the clay and rubbly limestone beds (Upper Lias) below the and, and also Ammonites, Belemnites, and the large *Pecten æquivalvis* from the Middle Lias or Marlstone underneath. Then, having descended the hill, we may plunge into a bath in the Chalybeate waters which issue from its foot after percolating through the ferruginous sands of which it is formed. The water strikes with icy coldness, so that one cannot remain in long.

Pennard Hill, which stretches away a few miles to the east, is in the centre of a district noted for its cider, a beverage largely drunk in Somersetshire, and which the farmers are proud to offer to any chance visitor.

To the north of the Mendips, in the vale of Wrington, there are many orchards, and good cider is made; the favourite apple is the "Court of Wick Pippin."[1]

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[1] The apple seems to have been originally imported into Britain by the first colonies from Gaul, and in particular by the British Hædui, a Celtic tribe, who settled in the northern and eastern parts of the county of Somerset. Hence we find the site of the present Glastonbury to have been distinguished, before the Roman advent, by the discriminating title of *Avallonia*, or "The Apple Orchard."—*History of Carhampton.*

The moors in the neighbourhood of Glastonbury, at Ashcot and Shapwick, are largely dug for peat.

We can hardly stay to go up Creech Hill, nor to visit Bruton with its fine church tower. Castle Cary itself is scarcely worth a visit, buried in the spurs of the Oolitic escarpment, with its church, one of the few in Somerset with a spire, though modern. When we get into this country, we find the eminences, as a rule, sheep-walks; the hill-slopes, orchards; and the vales, pasture land. Cadbury Camp, which lies to the east, on the road to Yeovil, is an outlier of Inferior Oolite, and one of the great strongholds in early British times. Cadbury is mentioned in old records as Camelot, and is said to have been, in the days of Good King Arthur, the Head Quarters of the Knights of the Round Table.

Queen Camel, which has some legend connected with King Arthur to account for its unusual name, is devoid of much interest. It possesses a sulphur spring, due, probably, to a decomposition of iron pyrites in the Rhætic shales whence it issues. It also has some good quarries in the Lias limestones, which are here brought to the surface by a fault, otherwise I do not recommend it as a dwelling-place, though I stayed there several weeks. There is no living on the fat of the land: beef I was told was "killed" twice a year, while mutton is to be had when the butcher from a neighbouring village has not sold all his stock on his previous rounds. One may, however, linger on by drawing supplies of soup and meat from Australia, and of fish from Labrador, obtained by a journey to Yeovil.

Yeovil is a busy market town, noted for its gloves. It has a fine Perpendicular church, and many pretty walks and sections of Inferior Oolite and sands to recommend it.

To the north and north-west we find an uninteresting tract of flat country, chiefly meadow land, and very wet and marshy in winter time. In the midst of this is the decayed town of Ilchester, formerly one of the most famous stations possessed by the Romans, and even till the coaches left the road, a place of some importance. Somerton is another decayed town; once the chief town of Somerset, it now presents a poor appearance. Its church, with the octagonal tower, not uncommon in the neighbourhood, is in the Perpendicular style. The well-wooded valley which lies to the east is very picturesque, as it winds away amongst the hills of Lias limestone, which are quarried largely at Kineton and the Charltons. Here and there at Hurcot we trace the Red Marl, which becomes very conspicuous in the escarpment which stretches away to the north by Sir Alexander Hood's monument; the line between the Red Marl and the overlying grey marls of the Rhætic series is well marked. These beds yield Alabaster, which has been worked in several places, particularly at Hurcot.

In the Red Marl in this neighbourhood, also in the vale of Wrington, and other parts of Somerset, the Teazel (*Dipsacus fullonum*) is much cultivated. Its dried head, which bristles with hard stiff spiny bracts, is used by fullers in dressing cloth, no machinery having as yet been found so well adapted for this purpose.

Near here a boring was carried down to a depth of about in search of Coal, but without success. The Red Marl "bottomed." In the Radstock Coal-field most of the mines through this formation, some even commence in the Inferior and penetrate the underlying rocks, the Lias, Rhætic beds, and Marl, to the Coal-measures, but the maximum thickness of rocks is much thinner on that side of the Mendips than it is south. There is little doubt that the Coal-measures occur to the of the Mendips, and at a workable depth: the structure of the Hills being, geologically speaking, an anticlinal or "saddle," has brought the older rocks to the surface in a fold or ridge, leaving the newer Coal-measures resting conformably on their flanks, part exposed or very thinly covered by the Secondary rocks on the nor of the Mendips, and entirely concealed on the South. A boring would probably have to be continued a thousand feet there to prove the question, and should the great Sub-Wealden exploration prove successful so far as regards the finding of coal, perhaps the landholders of Somerset may be induced to combine and make a trial sinking south of the Mendips.

II.—On a Skull of *Bos primigenius* perforated by a Stone Celt.

By James Carter, M.R.C.S., etc.

In 1863 the skull and a portion of the skeleton of a large extinct species of Ox (*B. primigenius*), which had been found in the peat of the Cambridgeshire Fens, and which apparently had been killed by a celt, was placed in the Woodwardian Museum at Cambridge. At the time of its deposition there a portion of the flint remained firmly fixed in a fracture in the frontal bone, being partially retained *in situ* by a mass of peat: as, however, this peat gradually dried, it crumbled away, and the celt became loosened and displaced; moreover, some small fragments of bone fell away from the margin of the wound, so that in its present condition the specimen merely exhibits an irregular fracture in the forehead, in which a fragment of a flint implement lies loosely; but it no longer furnishes conclusive and positive evidence to prove that the fracture was actually caused by the celt which occupies it.

The scientific value and interest of the object therefore must now in great measure rest upon the testimony of those observers who examined it soon after its discovery, and when it was in such condition as to admit of no doubt as to the correct interpretation of the facts which it presented.

I therefore publish a portion of a paper which I read before the Cambridge Philosophical Society in May, 1863:—

In January, 1863, some workmen who were employed in Burwell Fen, about ten miles from Cambridge, in digging through the peat for the purpose of quarrying phosphatic nodules from the Upper Greensand, came upon the skeleton of a large Ox—*Bos primigenius*. A few days after discovery, the upper portion of the skull, with the horn-cores complete, and with the peat from which it had been dug ll fresh about it, was brought to Cambridge by the men who had and it, and was purchased for a small sum by Mr. Farren, who as then actively engaged in collecting fossils for the Woodwardian useum. At the time of purchase the specimen was not known to ossess any unusual interest. It was not until an attempt was made o clear away a large boss of peat which adhered to the broken facial extremity of the skull that the fact was discovered which gives it a singular archæological importance, namely, the presence of a portion of a stone celt firmly fixed in a wound in the right frontal bone, partly penetrating the cavity of the skull, and slightly projecting from it. The peat so completely concealed the celt from view that the workmen of whom it was purchased were almost certainly not aware of its presence, or they would have mentioned it, as they are in the habit of collecting, and are quite familiar with, such objects, and could scarcely have failed to have recognized the nature of the flint, if they had seen it.

Having noticed this remarkable circumstance, I made a careful examination for the purpose of satisfying myself as to the authenticity of the specimen, and as to the credibility of the several points of interest which it appeared to offer. In this investigation I gladly availed myself of the critical knowledge and experience of Professor C. Cardale Babington and the Rev. T. G. Bonney of St. John's College. It was also closely inspected by many other members of the University and scientific observers, including Mr. John Evans F.R.S. (now President of the Geological Society of London). The general appearance of the peat which covered the celt, the arrangement of the small rootlets, fibres, etc., of which it was composed, the manner in which it was matted upon the flint, and had accurately moulded all its inequalities of surface,—these characters and appearances were so distinctly marked as to leave no doubt whatever as to the fact that the peat must have formed upon the celt after its implantation in the skull, and had not been subsequently disturbed. I insist upon this statement most positively, because the peat has since become dry and crumbled away, so that the appearances described above are no longer observable. The examination, however, while the peat was still fresh, was absolutely conclusive as to the fact that the flint could not have been recently placed in the position it occupies.[1]

The flint was at once recognized as being a portion of a celt of the Neolithic type. The greater portion of the surface is chipped, but at the broader extremity it is *ground smooth* for about a quarter of an inch from the cutting edge. In dimension it measures nearly 3 inches in length and 2¼ inches at its greatest width. The elliptical surface produced by the transverse fracture of the celt is 2 inches by ¾ of an inch. This implement is unusually thin and the edges very sharp, characters which render it all the better adapted for the purpose to which it has been applied in this instance. The greater portion of the fragment lies within the cavity of the skull, rather more than half an inch projecting from it. The transverse fracture is evidently an old one—the broken end being patinated equally with that of any other portion of the celt; and it is reasonable to infer that it was produced by the violence employed in killing this huge animal.

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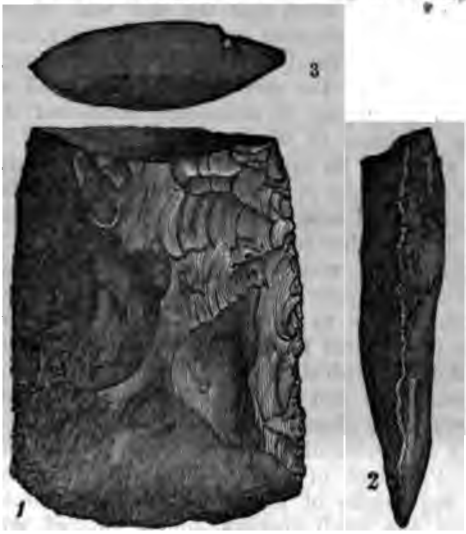
[1] In a short notice read before the Cambridge Antiquarian Society, on February 23, 1863, and published in the "Antiquarian Communications" of that Society, vol. ii. no. xiii. p. 285, 1864, Professor C. C. Babington expresses himself most positively on this *point, and asserts his* confident belief that the celt could not possibly have *been recently placed in the skull.*



Neolithic Flint Celt, found imbedded in the frontal bone of the skull of *Bos primigenius*, from the Cambridgeshire Fens (reduced one-third nat. size). Fig. 1. The broad surface. Fig. 2. The profile. Fig. 3. The end view.

On inspecting the wound in the skull, in order to ascertain the probable manner in which it had been produced, it is evident that it is precisely such as would have been made by the flint implement which is implanted in it: its edges are irregularly splintered and depressed, and in contour at the upper and outer part it corresponds accurately with that of the celt; unfortunately the skull had been broken across at the level of the upper margin of the orbits in such a way as to interfere with the fractured opening, and a portion of bone has fallen away, a natural separation having taken place at the mid-frontal suture, so that it cannot now be ascertained whether the lower portion of the opening corresponded in outline with that of the celt, as does the upper part. It is, however, clearly manifest from the characters of the wound, that the flint could not have been placed in its present position—either by accident or design—after the facial bones had been broken away from the rest of the skull. Moreover, the supposition that the fracture was produced during the life of the animal, or, at least, whilst the skull was yet fresh and retained its animal matter, is confirmed by the fact that the small fragments of bone which were detached from the edges of the wound did not fall away, as they would have done in a dried skull, but were apparently retained by the soft animal matter, and subsequently by the peat which filled the skull. As an indication that the wound was intentional, and not accidental, it may be observed that it was inflicted precisely in that small portion of the forehead which it was necessary to strike, in order to penetrate the brain, and so kill the animal.

It must have required a vigorous blow to have caused so comparatively blunt an implement to pierce the tough hide of the animal, covered by a dense coat of shaggy hair, and penetrate the cavity of the skull for nearly three inches. The force sufficient to have produced a wound of this depth through such dense structures must have been so great that it can be readily understood how it happened that the thin celt which was made use of should have been broken at about a level with the skin upon the animal's forehead. So small a portion projected as to render the extraction of the remainder from a fracture through fresh bone no easy matter: it was left in the wound, and has become an historical record of great interest.

So far as I know, the specimen is the only example which has yet occurred to prove *positively* that the stone celt was used by the early inhabitants of these islands for the purpose of killing animals. Skulls of extinct species of oxen have been found having a fractured opening in the forehead. Prof. Newton, in a paper read before the Cambridge Philosophical Society, states that he saw a skull of *Bos primigenius*, found near Ely, which had received such a blow as must have killed the animal, but how this wound was produced could not be ascertained. Professor Newton also states that at Thetford, in Norfolk, many skulls of *Bos longifrons* were found, all having a fracture in the forehead. Dr. Falconer informs us that a specimen of a vertebra of a Reindeer, "pierced through and through by a flint weapon which still remains imbedded in the bone," was discovered in a cave in Central France.

After it was ascertained that the skull possessed archæological interest, search was made upon the spot where it was found for other portions of the animal, and nearly the whole skeleton was recovered. The bones were found imbedded in the peat, and arranged nearly in their natural order. It would seem that the animal must have been killed upon the spot where the bones were found, and that the carcase or skeleton must have been buried in the peat soon after death, inasmuch as the bones afford no indication of having remained long upon the surface, exposed to the action of the various atmospheric and other agencies.

As regards the geological period to which this skeleton belongs, it seems tolerably certain that we may refer it to the later portion of the interval during which peat was formed; but any chronological considerations must be conjectural. The rate of growth of peat cannot be made to afford any very definite information as to the measurement of time, inasmuch as it varies so considerably according to the tribe of plants of which this substance is composed, and the *quantity of water by* which it is moistened or covered. It is impossible to hazard a conjecture as to the period in years since the formation of the Burwell peat commenced, but we know that—except in the dykes—it ceased when the Fens were drained, less than a century ago, and the occurrence of this skeleton proves positively that the district was so far drained as to be traversable at the time this ox was killed, and there is no evidence of any subsequent long-continued submergence; for undoubtedly the greater portion of the peat found above the skeleton was not formed upon it, but was the result of the carcase having sunk into it when in a moist state.

Indeed such few facts as we possess all tend to warrant the conclusion that this specimen need not be referred to any very remote period in time. It is of interest not with reference to the antiquity of man, but as affording evidence of the contemporaneity of man with *Bos primigenius*, as a proof of one especial purpose to which celts were applied, and as rendering it probable that this ox lived, and that the early inhabitants of the Cambridgeshire Fens continued primæval habits, to a much more recent period than has been generally supposed.

The celt (Fig. 1) is figured one-third less than the natural size. Fig. 2 as seen in profile. Fig. 3, section as shown at the broken proximal end.

III.—On Drift.

By J. G. Goodchild, F.G.S.
of H.M. Geological Survey.

In a letter to *Nature* for 14th May, 1874, Mr. Belt has expressed his belief that the presence of shells in glacial deposits, at whatever elevation they may be found, does not necessarily constitute a proof that the land has been depressed to that extent relatively to the level of the sea; but that in such cases as those of the drifts of the basin of the Irish Sea the shells occur in their present positions because they were thrust thither out of the bed of the sea by the ice-sheet which was advancing from the North.

Somewhat similar views with regard to other drifts had been previously advanced by Messrs. Croll and Tiddeman; but up to the time of the publication of Mr. Belt's letter no one had ventured, in print, to extend this theory to such deposits as those of Macclesfield and Moel Tryfaen.

The communication referred to gave rise to an instructive discussion, which was brought to a close by a letter from Prof. Green, in which attention was recalled to the fact that the drifts in question were finely stratified, and that, therefore, they could not have originated in the way suggested.

As no one since has ventured to re-open the discussion, I propose to take advantage of the renewed interest in the subject likely to be occasioned by the publication of Mr. James Geikie's paper on "The Occurrence of Erratics at Higher Levels than the Rock Masses from which they have been derived," which I have just read, to re-state some of the arguments used in a paper read to the Geological Society on the 24th of June last, in which I have sought to establish a new theory of the origin of drift deposits that seems to throw some light upon this and some other imperfectly understood points in Pleistocene Geology.

Much of the difficulty which has hitherto been felt in accounting for the transportal of marine shells to high levels by means of ice in the way suggested by Messrs. Croll, Tiddeman and Belt, has arisen through what is probably a misconception respecting the method of formation of the beds in which the fossils occur. If it can be proved that the greater part of the till has been accumulated, in the first instance, between the ice and the rocky bed over which it was passing, then it would follow that the force resulting from the advance of the Irish Sea ice-sheet must have been sufficient, not only to crush and completely destroy all traces of any organisms which may have found their way beneath it, but also to knead up the beds in which they occurred in such a way as completely to obliterate all traces of stratification. To deny this, as Mr. Bonney has pointed out, is to deny to ice that efficacy as an abrading agent which those accustomed to the practical investigation of glacial effects see every day additional reason to ascribe to it.

Referring to descriptions of the drifts of the Basin of the Irish Sea, we find that most writers concur in describing those of the low ground as divisible into three groups—a lower till group, with traces of stratification throughout, and occasional seams of sand and gravel;—a sand and gravel series, which includes occasional thin beds of till, and deposits of loam and laminated clays;—and an upper till, resembling that beneath in every essential respect, except that it is occasionally noted that it contains a larger per-centage of far-derived boulders than does the older deposit. Between the lower till and the sand and gravel series, and also occasionally between this and the upper till, the junction is uneven, from the denudation effected in the interim between the formation of the overlying and the underlying beds.

References to any contortion of the beds on the large scale are rarely to be met with, and the few instances that have been described show that the amount of derangement is wholly incommensurate with that which must have resulted from the long-continued onward movement, over beds which are yet unconsolidated, of a mass of ice that was certainly not less than 2000 feet in thickness.

Following the drifts inland towards the heads of the principal river-basins, the medial sand and gravel group is locally found to pass horizontally, through frequent alternations of sand and gravel and till, into a deposit which cannot be distinguished from ordinary till, so that the three subdivisions of the drift are no longer traceable.

It is usually the case that the proportion of washed and water-worn material included in the whole of the drift of any given spot is in exact proportion to the area of the catchment basin lying above it. In other words, the quantity of water-worn drift, and the volume of water flowing along the principal river, at any given part of a district, almost always bear an exact proportion to each other; so that, near the sources, as a rule little else than till is to be met with;

lower down alternations of till with sand and gravel begin to occur; and at a still greater distance from the head waters it often happens that nothing but accumulation of water-worn materials make up the whole mass of the drift.

Where natural or artificial sections afford an opportunity of examining the internal structure of the drift mounds, we find that the beds are often, perhaps nearly always, wrapped round a core of the underlying solid rock; and, what is still more remarkable, the bedding planes of the outer parts of the deposit not rarely conform in slope to the adjacent outer surface of the drift mound; and this holds good whether the outer part be clay and the mound form a drumlin, or sands and gravels occupy the surface and the deposit assume the form of an esker.

In those places where the proportions of till and gravel are about equal, most of the sections show lenticular deposits of laminated gutta-percha clays, interbedded with the sands and gravels, and with both the upper and the lower tills. The clays are often sufficiently fine to exhibit a shining surface, when cut, and are arranged in exceedingly thin leaves, forming masses which are occasionally from ten to fifteen feet in thickness, but of very limited extent horizontally. Notwithstanding their exceeding fineness, they are often strongly false-bedded, in some cases up to angles of thirty degrees, or even more; and the false-bedded laminæ frequently repose upon, and are again covered up by, other laminæ, which have other lesser degrees of inclination, or are even quite horizontal. But the most noteworthy feature about these sections is the intercalation of highly contorted and crushed loams and laminated clays, forming bands from a few inches to several feet in thickness, among perfectly horizontal, or at all events clearly undisturbed strata. In some sections these appearances are repeated four or five times in the same mass, the beds between the crushed and contorted beds being usually underanged. Where the clays in the till exhibit these phenomena, the slickensided faces, which Mr. James Geikie has termed "striated pavements," are usually to be met with.

It is important that attention should be called to these laminated clays, as they locally occur as well in both tills as in the middle group; and, clearly, no theory of the origin of the drifts can be tenable if it do not also offer a satisfactory explanation of the enigmatical phenomena referred to.

Generally, the different members of the drift are so closely interwoven, so nearly resemble each other in regard to the direction of transportal of the included stones, and the species of mollusca dispersed throughout the series—where it is fossiliferous—so often exhibit the same anomalous intermixture of Celtic, Lusitanian, Boreal, and Arctic forms, that one cannot resist the conclusion that the whole series must, in some way or other, have had a common origin.

In framing any theory of the origin of drift we have therefore to bear in mind the following points:—

The component materials vary in size from mere grains of sand up to blocks which are fifteen or twenty feet in diameter, or in some cases even larger.

A large proportion of the stones are either more or less blunted and striated, or else show obscure traces of striæ, which evidently were at one time much more distinct.

Angular and unscratched stones occur throughout the till, frequently outnumbering those that are glaciated; and well-scratched, and quite unworn stones are by no means absent from the sand and gravel group.

The proportion of material water-worn and sorted according to size, and of blocks which are arranged with their longer axes parallel to the horizon, steadily diminishes as we approach the heads of the river-basins.

Much of the drift lies in elliptical mounds, which frequently spring from a rocky projection; and their longer axes, in most cases, conform in direction to that of the general line of waterflow of the place where they occur.

Not often, save at the heads of valleys, does the drift fill hollows: in the plains it is usually moulded over bosses and ridges of solid rock; and the slopes of the mound in this case conform to the subjacent bedding planes of the drift.

Pipes of fine sand and gravel sometimes extend several feet upwards through the till; and inclined and rudely lenticular masses of finely laminated clay occur equally in the sand and gravel group, and in the upper and lower tills.

The limited horizontal extent of each mass of this gutta-percha clay is shown to be original by the conformity between the outer lamination and the bounding surfaces of each mass.

Lastly, undisturbed stratification may usually be found extending a long distance horizontally through each section: where crushed and contorted beds occur, they are either intercalated between undisturbed strata, or, if they occupy the surface, the beds beneath show no derangement.

As the marine theory of the origin of till leaves so many facts unexplained, that it is being rejected by most glacialists, it will be passed by here without further mention.

The theory which seems to find most general acceptance with geologists is that which assumes that the till originated through the long-continued scraping and rasping of the rock surface by the gritty sole of the ice-sheet, studded with boulders that had been wrenched from its rocky bed, the resulting detritus being shoved along between the moving ice and the rock to the sheltered spots where it finally accumulated as till.

It is obvious that a deposit formed in this way must necessarily be quite unfossiliferous, because the enormous force exerted upon the mass by the advancing ice-sheet must have been sufficient to grind any organisms which chanced to find their way there into the finest mud.

For the same reason such a deposit must be quite devoid of stratification. The ice which exerted so powerful an abrading influence upon every part of the most irregular and hardest rock surface, glaciating boss and *cavity alike, could* not fail to knead up any unconsolidated beds over which it might pass, so that every trace of stratification would speedily be obliterated.

The sliding motion communicated to the parts of the *moraine profonde*, under the enormous pressure of the superincumbent mass of ice, must have caused the included rock fragments to arrange themselves with their longer axes parallel to the direction of motion of the bottom of the ice, and must have given rise to a kind of slickensiding along planes at right angles to the line of pressure, so that along those planes the till might be expected to exhibit more or less distinct traces of a kind of cleavage.

Lastly, the greatest thickness of till must have accumulated in the comparatively sheltered spots; in situations exposed to the full force of the icy currents little or no till could gather, save in the form of thin lenticular patches.

What we actually find is a series of beds which locally contain a few even well-preserved fossils, and which are often distinctly stratified throughout, and occasionally exhibit many alternations of beds of till, sand and gravel, loams, and laminated clays. Throughout, the series is characterized by the presence of boulders the longer axes of which are found lying in every possible direction. And, lastly, the till may be found in as great force in the upper parts of wide valleys in which it can be shown that the ice travelled upwards —for instance the Eden Valley—as in the sheltered spots only within which it ought to occur according to the moraine profonde theory.

Doubtless, the want of accordance between the leading points of the moraine profonde theory and the observed facts has been felt with more or less force by nearly all geologists who have practically investigated the subject. Other objections will probably occur to every field geologist, but those indicated above seem to warrant us in seeking to replace the moraine profonde theory by any other which will better harmonize an equal number, or a greater number, of facts.

The laminated clays, which have been referred to above as forming one of the members of the drift series, afford unmistakable evidence that whatever agent produced them continued over the spot all the while they were being formed. Small stones are frequently, and even boulders, that is to say stones of more than one foot in diameter, are occasionally found in the midst of them. Any current sufficiently strong to transport these stones must have swept the fine clay much farther from the source of the current. They are distinctly false-bedded in different directions, and often at angles up to twenty degrees or more; whence it is obvious that they cannot have been thrown down *in* water, otherwise the clay would have been spread out in sheets with laminæ nearly or quite horizontal. They are made up of countless laminæ of exceeding thinness, which show alternations of sands of different colours and of various degrees of coarseness, from which it is clear, that whatever produced them acted intermittently over the same spot through long periods of time. Puckered and highly contorted bands alternate with others in which the bedding planes remain undisturbed; therefore the crumpling must have been going on every now and then during the formation of the beds; and the agent which produced the crumpling could not have accomplished it by an endlong thrust, or more of the underlying beds would have participated in the disturbance. The principal faces of oblique lamination in the clays very frequently, perhaps nearly always, conform in direction to the outer slope of the mound in which they occur, and usually, also, to the slopes of the rock over which the drift is moulded; where the till has been denuded, the surface of the overlying sand and gravel usually follows the outline of the till over which it lies, whence we may conclude that the drift-forming agent was detained over one particular spot until the whole of the drift, till, sand and gravel, loam, and laminated clay, had accumulated.

Taking another line of inquiry, we find that nests and vertical pipes of sand and gravel frequently extend upwards through a considerable thickness of till, in such a way as to show that the building up of the surrounding till went on simultaneously with the deposition of the fine sand and gravel: this again seems to point to the detention, over the same spot, of the agent which produced both results. Evidence of the same kind seems to be afforded by the occasional presence of well-glaciated and quite unrolled rock fragments in the midst of thick deposits of sand and gravel; the amount of rolling which was sufficient to efface the striæ from most of the stones could not fail to have acted alike on all;—there must have been something from which a continual supply of these scratched stones and angular blocks was being derived, while the other stones were being rolled into shingle. Such instances, doubtless, are rare in proportion to the distance of the mass of gravel from the head of the physical basin in which it occurs; but a careful search in almost any sand and gravel mound will usually bring one or more such instances to light.

Reasoning from these data last winter, I was led to the conclusion that the only agent by which we could satisfactorily account for these varied, and, in part, seemingly unrelated phenomena, was the great ice-sheet itself, throughout which the component materials of the various forms of drift were in some way or other dispersed.

It seems strange that so many geologists who have written about drift should have assumed that the stones and mud were confined to the bottom of the ice-sheet, and that the body of the ice was nearly or quite free from detritus. Yet mention of even considerable quantities of rock fragments imbedded in icebergs is frequently made by voyagers, and all writers seem agreed that stones and mud do occasionally occur in the bodies of the Swiss and other glaciers. Had no mention been made of these included stones, their presence in the ice-sheet might have been inferred from the now undoubted recurrence in the ice of crossing currents, the probability of the existence of which was long since pointed out by Professor Ramsay.

The evidence for the existence of these crossing currents may be *stated as follows:—*

Where the general direction of glaciation within a small area is known, it is often found, as was pointed out by Mr. James Geikie in the 'Great Ice Age,' that the striæ show that the ice was more or less deflected on meeting with an obstacle, while the higher currents moved in the general direction; so that just above the obstacle the ice must often have been flowing at right angles to that which was passing the rock below.

On the north-east side of Wastdale Crag, near the Granite Quarries, a protuberant boss of the granite—about four feet by three in diameter, and standing up like a short column about two feet above the general surface near it—shows on the top striæ ranging north-easterly, or in the direction common in the immediate vicinity. From the bottom of its most south-westerly part, that is to say the point directly opposed to the current, the striæ diverge upwards in the form of a fan, winding spirally upwards round the sides until they gradually merge into the main direction near the top. Along the lee side, near the top, a small channel along a joint extends in a direction at right angles to that of the top current, and although it is only six inches below a part of the block showing well-marked north-easterly striæ, this tiny channel exhibited distinct glacial scratches in the direction of its length, or exactly at right angles to those just above it; so that in this instance the ice immediately above the block must have crossed at least four distinct streams, making with it every angle up to, or even beyond, a right angle.

It is not easy to bring this home to the mind without the aid of a diagram; but some conception of the phenomena may be formed by noticing the way in which the water of a river flowing over a similar obstacle splits and passes round the block, pressing against the sides, and closing in behind as a backwater; while the direction of the stream immediately above the diverging currents would remain nearly unchanged.

What has been stated of the small block of granite will apply equally well to at least the greater part of the Fell of which it forms a part. The recent operations of the Shap Granite Company have laid bare many well-glaciated surfaces of the granite, which clearly show that, whatever direction the ice may have had at high levels, in the movements of its lower parts, it tended more or less to follow the shape of the ground immediately beneath it, exactly as it did on a smaller scale in the case of the rock just mentioned. It would be easy to multiply such instances, as the ice seems everywhere, under like circumstances, to have behaved in a similar way.

Where the body of the ice was impelled up the valleys, and many instances of the kind could be adduced, there may sometimes be found indications in the directions of the striæ at high levels to prove that the higher strata of the ice were acted upon by currents flowing completely at right angles to the course of the lower parts, so that from directions parallel with the length of the valley low down the striæ tend more and more to change into the direction of the higher current as they are followed towards the hill tops on each side.

Professor Ramsay long since stated it as his belief that there were not only crossing currents in the ice-sheet, but that it was quite possible that some of the higher parts of it may have moved in directions directly opposite to the course taken by those at a lower level.

Many phenomena, otherwise inexplicable, may be easily enough accounted for by this theory; such, for instance, as the transportal of drift in directions opposite to the movements of the sole of the ice as indicated by the scratches.

One remarkable instance of this kind has lately come under the writer's notice, in which the general direction of transportal of part of the drift was clearly up the valley, the far transported drift being intimately mixed up with detritus of purely local origin, and the whole deposit left in considerable masses in the bottom of the higher end of the valley. Yet a small rock exposure in the stream, about two miles from the head of the valley, exhibited a well-striated rock surface, the appearance of which clearly showed that the ice which formed the striæ must have moved *down* the valley. The presence of the drift of extraneous origin, with undisturbed lines of bedding, *above* the glaciated surface, precludes us from referring these striæ to any after glaciation, which must inevitably have swept out all traces of the older drift.

We are, therefore, led to conclude that in this case, as in probably many others, the bottom ice, acting more under the influence of downward pressure than the higher parts, moved downwards and outwards to the point where its outward motion would be stopped by the up-flowing ice, whilst the higher strata, being more affected by the local set of the ice currents at the surface, which were acting horizontally, and being less influenced by the overburden of ice, would move towards the head of the valley up to the point where the local ice would check or alter its course. In this case, therefore, it is easy to see how the two currents, over any given spot, may be moving in precisely opposite directions at the same time.

An exact parallel may be found in the undertow flowing seawards from a beach, while a little higher up the breaker is advancing towards the shore.

In cases similar to that of the ice currents just referred to, a little consideration will convince one that there must have been somewhere a point at the bottom of the ice at which the two opposing forces, the outflowing and the inflowing, must have been exactly equal in energy, and in which, therefore, the line of least resistance must have lain in an upward direction. This course, therefore, the ice would take; and many, if not all, of the stones set in the bottom of the ice would go up with it. In proportion as the stones rose in the body of the ice, they would be brought more within the influence of the higher currents, and would in that way be occasionally carried backwards in the ice over the spot at which they first worked into it at a lower level. The crossing current, before referred to, would tend to bring about a similar result. Many stones which *were fixed in* the sole of the crossing streams would, on the blending of the two currents, find their way into the body of the conjoined stream without first working downwards to the base. When once they were fairly into the ice, gravity would have but little effect upon their position; but they might be floated, so to speak, across wide valleys, or over lower currents, transporting other boulders in different directions without working downwards to any appreciable extent.

The observations of Prof. J. D. Forbes, lately extended in the paper by Mr. James Geikie, referred to above, would tend rather to show, that instead of working down, any solids included in the body of the ice would tend sooner or later to find their way to the surface, through the wasting of the upper parts of the ice under the influence of the sun, warm air, and rain; while its general level was kept constant by accretions from the various feeders of the trunk stream. Prof. Forbes and Mr. Geikie consider that the boulders might work up to the surface of the ice in this way from any part of the bottom; and, after reading Mr. Geikie's paper, I am inclined to think that the filling of the ice-sheet with stones and mud, in the ways that I have suggested, may have been quite subordinate to the combined action of ablation and turgesence, treated of by the authors just named.

What it is particularly wished to call attention to here is the fact that the direction of transportal of boulders is very often at right angles, and in a few cases is directly opposite to the course taken by the sole of the ice-sheet, as indicated by the glaciation of the rock surface, or by the direction in which other boulders have travelled.

Thus, the glaciation of the Isle of Man has been shown to have been from the north-east, or from the mountains of the Lake District; while the course taken by the boulders has been from the north, north-east, and perhaps also from the north-west.

Another case is that of the glaciation of the ground about Lancaster, which Mr. Tiddeman has shown to have been, generally speaking, from north to south, while the course taken by the boulders from the western part of the Lake District and from Scotland lies in a south-easterly direction.

Again, the boulders from Galloway have travelled eastwards towards Newcastle; south-eastwards up the valley of the Eden, and thence over Stainmoor to the Vale of York; and, southwards, skirting the high ground of the Lake District as far as Ravenglass, whence their course was south-easterly, to near Manchester, and thence southwards to an unknown distance.

On the other hand, boulders have radiated far in nearly every direction from every mass of high land, often in courses exactly opposite to those taken by the extraneous drift, with which, locally, they may happen to be associated.

Thus Prof. Sedgwick has mentioned the occurrence of boulders from the Lake District in those parts of Galloway which have furnished the greatest number of erratics to the Lake District itself.

Even in those parts of the Lake District in which the majority of the boulders have moved outwards at low levels, we find that some of the very same rock has been transported in opposite directions towards the heart of the mountains by the strong upper currents which were setting in from Scotland.

Many similar cases occur in the Eden Valley, but perhaps the most striking is that of the very peculiar granite of Dufton, close under Cross Fell, blocks of which have been floated in the ice, amongst other directions, across to Shap, where I have picked them out of the till; while, on the other hand, the well-known granite of Shap is well represented by several large blocks close to the Dufton granite *in situ*. Both of these opposing currents have again been crossed at various other angles up to right angles by others which conveyed the boulders from the north and north-west of the Lake District—as, for instance, the red syenite of Buttermere—and the numerous varieties of granite and other crystalline rocks from Galloway, up the Eden Valley and over Stainmoor. It is easy to multiply examples, but those just given will probably suffice.

One explanation of these facts assumes that the very fact of the difference between the directions of transportal of boulders and the trend of the scratches is in itself sufficient evidence of the action of floating ice; but the boulders which, according to this hypothesis, have come by floating ice, occur under precisely the same conditions as the associated boulders of local origin, and usually occur throughout all the drifts of a district in which they happen to be found. Hence, whatever explanation is adopted for one class of boulders will apply equally well to those with which it is associated.

In some of the wider valleys, in situations eminently favourable for the formation of detached glaciers, striæ are to be found going right across the path which an ordinary glacier would take; and often elsewhere, other such traces of the ice-sheet as could only have been formed at or near the climax of the Glacial Period remain unobliterated by any newer set which followed the ordinary lines of drainage.

On the whole, therefore, the evidence seems to point to the conclusion that after the climax of the Glacial Period, the great ice-sheet did not break up by degrees into smaller detached glaciers which would efface from the low ground all traces of the previous occupation by the larger stream, but that it quietly melted away without again advancing over any of its old ground.

It will be well here to take a review of the condition and probable contents of the ice-sheet just before it began to ebb.

It has been shown that the effect of the various crossing currents at different levels would be to bring together, over any given spot, a great variety of boulders from various sources, and which would be dispersed throughout the entire thickness of the ice. The directions in which these boulders had moved need not necessarily coincide with the path taken by the sole of the ice, but would in many cases be even directly opposite. The ablation and compensating turgescence, consequent upon the pressure of fresh supplies from the various feeders of the main stream, would tend to bring anything in the ice to higher levels, until it finally rose to the surface at whatever elevation this may locally have had. Any organic remains which may have found their way into the ice through a crevasse or otherwise would also be distributed throughout the ice in the same way as the accompanying stones.

There must have been a time in the history of the great ice-sheet when the waxing glaciers, before they became entirely confluent, projected so far seawards that their advancing ends would plough the sea-bottom, pushing before them the whole of the loose accumulations of mud, sand, and shingle, with their inclosed remains of all the animals which had lived and died there since the preceding glacial period, which may possibly have dated back to Pliocene times.

Hence such a sea-bottom might be expected to include relics of the various faunæ that had inhabited the spot under the greatly varying changes of climate which probably came about between the two glacial periods. Thus we might reasonably expect to meet with traces of the successive occupation of the sea-bottom by the various colonies of Lusitanian, Celtic, Boreal, and finally of Arctic species, which would respectively obtain stations there as the successive changes of temperature of the sea-bottom favoured the encroachments of one province upon another.

When the Glacial Period had so far advanced that the glaciers began to join ends, the submarine moraines, which were pushed before the glaciers, would find their way on to the confluent streams, and thus the old sea-bottoms would come to be blended in the ice with the vast quantities of detritus which were being borne outwards from the high land.

As the ice increased in thickness, the included marine remains would follow exactly the same course as the associated stones, and would be carried inland to high levels wherever they were so impelled by the local set of the surface currents of the ice.

Of course the shells would not go inland unless there were currents setting landwards in some part or other of the ice, and it is equally clear that unless one or other of these currents had somewhere crossed the sea-bottom, or had received accretions from other currents which had done so, no marine exuviæ could well find their way inland in the ice.

Animal remains, whether fossil or recent, included in the ice-sheet, may have drifted long distances without being greatly crushed, as it would only be in those places where there was much inequality in the pressures upon the more easily fractured remains that they would be at all broken.

In the ice, away from impediments, the pressure upon them would practically be equal in every direction, and they might, therefore, drift for ages without being much the worse for their entombment.

The case of the bodies of Dr. Hamel's three guides which were recovered after drifting forty years in one of the Swiss glaciers (Tyndall's Glaciers of the Alps, p. 76); the instance of the knapsack referred to by Messrs. Forbes and Geikie; and, still more to the point, the *glass bottle* which drifted for ten years with the above-mentioned knapsack (Occasional Papers, pp. 193–195); the *geological* hammer which Prof. J. D. Forbes lost for fifteen years in the

Glacier de Lechaud, and which was afterwards recovered "with the iron not rusted, nor the wood decayed,"—all show that under favourable circumstances bodies may drift for years in the ice, and yet be little the worse for their journey. Why, then, should we assume that a few even fragile shells might not be preserved in the great ice-sheet while they were drifted from the sea-bottoms to the tops of the mountains?

When the ice began to melt away, the largest amount of liquefaction would take place at the surface, but terrestrial heat must also have had its share in melting the ice at the bottom.

Wherever channels of any kind existed beneath the ice,—and we have abundant proof that the rock surface itself was very irregular, —the water resulting from the liquefaction of the ice would follow the descent of the surface along these channels towards the lowest ground it could find. By this means the stones and mud which were being liberated as the bottom of the ice melted, would be swept away and the channels kept open. On the banks the case would be otherwise. Here, as the mud and stones melted out of the ice, the accompanying water would drain into the lower channels, while the clay and stones would be left behind, and it is easily conceivable how sheets of water-sorted materials might occasionally alternate with the unstratified clays in places where a shallow channel had been temporarily formed between the continually rising bottom of the ice and the surface of the sediment, if one may thus use the word, which was accumulating between it and the underlying rock. The detritus which was being liberated from the surface of the melting ice must also have occasionally found its way down through crevasses or otherwise to be mingled with, or arranged amongst, the more clayey deposits which were forming beneath.

It is clear that close to what one may term the margin of the physical basins of each district, the volume of water of liquefaction flowing past any given spot would be less than would be found nearer the centre and the lower end of each basin, because, in addition to that derived from the melting of the ice in the immediate vicinity, there would be also all that which was flowing downwards from the higher parts of the basin. It would therefore follow, that the farther from the main water-shedding lines, the larger would be the proportion of water-worn and water-sorted material.

High up in the valleys the deposition of the clay and stones, between the continually thinning ice and the underlying rock, would go on uniformly until all the ice had melted; because there would be little more water passing beneath than that resulting from the melting of the ice immediately above. But where the volume of seaward-passing water was very great, as it must have been in the bottoms of the valleys, it might be expected that occasional variations in the velocity of the sub-glacial streams would cause them to cut channels into the older banks of clay which were left when the streams were at a lower ebb. The increased transporting power of the streams would tend to fill these channels with water-worn drift of different degrees of coarseness; and when the streams again sank to their ordinary levels, the deposition of material of lesser degrees of coarseness would again go on over the lately formed channels.

Still farther from the watershed so much water would be flowing between the ice and the rock in the low grounds that the finer parts of the clay—in places which, farther up the valley, would be out of the reach of the water—would be carried away, so that beds of loam only would be left to represent the more clayey deposits at higher levels.

It is obvious that the farther from their origin the stones were rolled, the greater amount of attrition they would undergo, so that stones which, when melted out of either the top or the bottom of the ice, were either angular or well scratched, would soon be rolled into shingle undistinguishable from ordinary river gravel; and between these extremes we should find every degree of water-wornness, and thus get many stones from which the scratches would be only partially effaced, or would retain what Prof. Ramsay terms "ghosts of scratches."

When at its lowest ebb, the water of the sub-glacial streams would permit of the formation of laminated clays in the minor tributary channels. The thin sheets of water highly charged with mud would deposit part of their load as a thin film of clay on the surface over which they were flowing, and the long continuance of such action would, in the end, give rise to deposits of considerable thickness. The presence of the ice overhead would help to scatter throughout the mass the same proportion of stones and boulders as was being dropped around in the other deposits accumulating near; but the proportion of clay to stones in the gutta-percha clays would be larger by the quantity that was being abstracted from the beds from which the clay-bearing streams took their rise. In the end, we should thus get a deposit of clay of various degrees of fineness, in exceedingly thin laminæ, often of different colours, and occasionally exhibiting false stratification up to high angles. We should be prepared to find it varying from a clay in which stones are only occasionally found, to a deposit in which scratched stones occurred in the normal proportion, and which would thus pass insensibly into the character of the ordinary stony clay around it;—the difference in character depending entirely upon the time any given thickness of each deposit took to form.

Much interest attaches to the origin of these clays now that a human bone has been found beneath them in the Victoria Caves by Mr. Tiddeman, to whom also geologists are indebted for calling attention to the true nature and importance of these laminated gutta-percha clays.

It may reasonably be asked whether the enormous downward pressure of the ice upon the underlying beds would not tend to crush and contort them more or less, especially if, as is probable, the ice-sheet occasionally settled down by small starts upon the half consolidated beds which were accumulating between its lower parts and the rock.

To this it may be answered that abundant evidence of such crushing of the drift exists, although the singularity of the appearances so uced has led observers to refer the phenomena to other causes.

Indications of such action are to be found in the slickensided faces in the till to which Mr. Geikie applies the term "striated pavements." These closely resemble the appearances presented by the faces of divisional planes in any rocks near faults, the striation in both cases being due to the slipping in the plane of least resistance of one part of the rock over another under great pressure; the only difference in the two cases being that in the case of fault slickensides, the greatest pressure was applied horizontally, and the striations, therefore, run in a vertical plane; while in the till the pressure being applied vertically downwards, the plane of least resistance lay horizontally, and the movement has consequently taken place in that direction.

But the contorted and crushed stratified beds associated with the till afford the best proof of the down settling of the ice sheet.

In these beds we often find repeated alternations of beds which are little if at all disturbed, between bands of occasionally only two or three inches in thickness, in which the laminæ are so violently puckered and contorted that the lines of deposition are often bent three or four times in succession over each other within a few inches. These appearances, too, seem to be almost invariably accompanied by the "striated pavements," and by innumerable faults of very small downthrow.

Probably the true explanation of most of these contorted bands is that they are due to the periodical settling down of the ice upon the top of pliant strata, which had not had time to reach the same stage of consolidation as those immediately below. They, therefore, yielded readily under the pressure of the superincumbent mass of ice, producing the wildest confusion of the stratification as far downwards as the more easily squeezed beds extended; but not affecting those beneath to any great depth, as must inevitably have happened had the puckerings been due to the impact of a great mass of floating ice in the way often suggested.

When the ice again came to rest, the quiet deposition of the beds would again go on, and the crushed, contorted, and faulted beds would be again covered up with undisturbed strata, which again in their turn might be succeeded by another set of crumpled beds without being themselves affected by the causes which disturbed the overlying strata.

Sands and gravels would not exhibit these phenomena in as marked a way as the accompanying laminated clays, but they also bear some traces of the same irregular downward pressure.

It was remarked above that the sand and gravel mounds, even when they have all the characteristics of eskers, are frequently seen to be moulded over bosses of rock, and to spring from headlands in the same way as spits of sand and gravel project seawards from the middle piers of bridges over shallow rivers, and are heaped up midway between the currents which come through the arches.

In addition to this, the occasional presence of patches of till and of well-glaciated boulders in the mounds—the conformity between the *outer form and their internal* structure, and the general resemblance to the drumlins in everything but in the proportion of water-sorted material, and in their more irregular and steeper sided form—all incline one to the belief that these sand and gravel mounds have accumulated in the same way as the closely related and adjoining drumlins.

Had they originated as the terminal moraines of the retiring ice-sheet, there seems to be no reason why they should so often exhibit the peculiarities mentioned above.

Were the heaping up of the gravel over rock mounds merely an accidental circumstance, and the mound but the remains of a once continuous plain, we ought to find, in all cases in which it occurs, the lowest false-bedding planes inclined at the highest angles, and there should be a gradual approximation to horizontality in any given bedding plane in proportion to its distance from the underlying rock; instead of which, in all the examples that have hitherto come under my notice, the principal false-bedding planes either coincide in slope with that of the under-lying rock surface, or, more usually, they exceed it in inclination.

I am therefore inclined to think that the eskers originated in the way I have suggested; that is to say, that their position in the first instance was determined by the mounds upon which they stand having been high enough above the stronger currents of the sub-glacial streams to allow of the occasional heaping up of sand and shingle washed out of the accumulating till higher up the valley, or carried down from the surface. As the ice wasted, the vast quantities of water-worn material, continually melting out of its surface, would be washed down the moulins and crevasses to the bottom, where, if they descended upon mounds out of the reach of the levelling action of the stronger parts of the sub-glacial streams, they would remain nearly as at first thrown down; whilst the detritus which fell into the channels would speedily be swept away to lower levels, leaving nothing but the bigger blocks to mark their former presence on the spot. This process, long continued, would give rise in the end—as the last touches would be given to their form as the ice-sheet was upon the point of vanishing—to those strange hummocky mounds, the land-locked hollows in which have been so sore a puzzle to all geologists who have looked thoughtfully into the matter.

I cannot, therefore, avoid the conclusion that all, or nearly all, the forms of drift with which I am acquainted, or have read of, save, perhaps, some of the low level moraine beds, and the tiny moraines of the few glaciers which came after the melting of the ice-sheet, have originated in the course of long periods of time *beneath* the ice-sheet in the way detailed above; and the conclusion seems equally inevitable that the organic remains entombed in the ice would be left in the same way as were the accompanying stones, at all elevations up to the highest points reached by the ice; and that, therefore, the presence of marine exuviæ in stratified, or other drift, at whatsoever elevation they may be found, does not in itself prove that in Glacial or Post-Glacial times the places where they occur ever reached by the sea.

IV.—NOTES ON SOME SILURIAN ENTOMOSTRACA FROM PEEBLESSHIRE.[1]

By Professor T. RUPERT JONES, F.R.S., F.G.S.

SOME specimens of dark olive-grey mudstone from Peeblesshire, collected and shown to me by Mr. D. J. Brown, contain several internal and external casts of small bivalved Entomostraca.

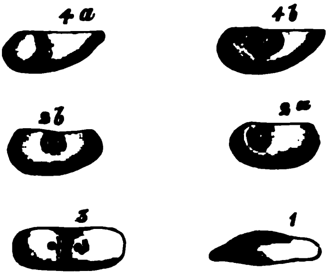


FIG. 1. *Bairdia ? Browniana*, right valve.
" 2*a*. *Beyrichia impendens*; left valve.
" 2*b*. *B. impendens*, var. *tuberosa*; right valve.
" 3. *Primitia protenta*; right ? valve.
" 4*a*. *Entomis aciculata*; right valve.
" 4*b*. *E. aciculata*; right valve, crushed.
(All magnified about six diameters.)

1. *Bairdia ? Browniana*, Jones, 1871, MS. [Fig. 1.]—Two internal casts; fusiform, with one margin [dorsal ?] more convex and more sinuate than the other, and with one end much more acute than the other, which is narrow and neatly rounded. Length of valve, $\frac{1}{14}$th inch; breadth or height, $\frac{1}{40}$th inch.

This small and somewhat obscure form most nearly conforms in shape with some of the elongate subtriangular fossil "*Bairdiæ*," such as *B. siliqua*, Jones, and some of the recent *Macrocypridæ*, etc. In its size, however, and (as far as can be seen in the casts) in its shape and proportions, it differs from all the other forms; it may, therefore, be catalogued as *Bairdia ? Browniana*, taking its name from its discoverer. The very minute, elongate, Silurian *Cythere Grindrodiana* (Annals Nat. Hist. ser. 4, vol. iii. p. 212, fig. 1) is readily distinguished from this Bairdia-like species.

2. *Beyrichia impendens*, Jones, 1869, "On the Palæozoic Bivalved Entomostraca," Proceed. Geol. Assoc. 1869, p. 11, figs. 4*a*, 4*b*. [Figs. 2*a*. 2*b*.]

This variable little *Beyrichia* is represented among Mr. Brown's specimens from Peeblesshire by casts of several individuals, in which the dorsal furrow is variously developed (and altered by crush), as well as its associated tubercle. In some specimens one side (hinder) of the furrow is so much elevated as to form an additional though small tubercle, making an unequal pair with the other or usual tubercle in the bosom or anterior curve of the furrow; thus approaching *Primitia mundula* in its bituberculate furrow. We will name this variety *tuberosa.*

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[1] Reprinted, with woodcut added, and correction, by permission, from the "Transactions of the Geol. Soc. Edinburgh," vol. iii. part 2, 1874.

All these specimens of *B. impendens* are rather more oblong than those met with in the Pentland Hills; and the three lobes of the valve are not so distinct. Length of valve, $\frac{1}{12}$th; breadth, $\frac{1}{30}$th inch.

3. *Primitia*[1] *protenta,* sp. nov. [Fig. 3.]—One cast is decidedly referable to an elongate-oblong, convex valve, with a centro-dorsal furrow and a pair of small distinct symmetrical tubercles, one on each side of it, along the middle line of the valve.

This is longer than *B. impendens* and its variety above mentioned, and more symmetrical; for it must have been almost cylindrical in the perfect state of united valves; and its two tubercles are lower down, further apart, sharper, and more equal than in *B. impendens,* var. *tuberosa.* Length of valve, $\frac{1}{12}$th; beadth, $\frac{1}{30}$th inch.

4. *Entomis aciculata,* Jones, 1871, MS. Annals Nat. Hist. 1873, ser. 4, vol. xi. p. 416; Monthly Microscop. Journ.[2] 1873, vol. x. p. 76. [Figs. 4*a*. 4*b*.]

Several casts indicate a small *Entomis* related to *E. impendens,* Haswell ("On the Silurian Formation in the Pentland Hills," 1865, p. 38, pl. 3, fig. 11), but narrower and more pointed in front, and bearing a subcentral pointed tubercle, or spine (well-marked on some external moulds of the valve), low down, and in front of the long transverse furrow, which is characteristic of the genus. Length of the valve, $\frac{1}{16}$th; breadth, $\frac{1}{30}$th inch.

NOTICES OF MEMOIRS.

I.—On the Silurian Leperditiæ of Russia, etc. By Magister Fr. Schmidt. [Miscellanea Silurica. I. Ueber die russischen silurischen Leperditien, mit Hinzuziehung einiger Arten aus dem Nachbarländern. Von Mag. Fr. Schmidt, Mem. l'Acad. Imp. des Sciences de St. Pétersbourg, vii. série, vol. xxi. no. 2. 1873.]

In this monograph of the *Leperditiæ* of Russia and the neighbouring countries, M. Fr. Schmidt has revised the known *Leperditiæ* and *Isochilinæ,* and has added several new species. He figures and describes three *Isochilinæ*:—*I. Biensis* (Grunewald), *I. punctata* (d'Eichwald), and *I. Maakii,* nov. sp.; and ten *Leperditiæ*:—*L. grandis* (Schrenck), *L. Barbotana,* sp. n., *L. Tyraïca,* sp. n., *L. Angelini,* sp. n., *L. Balthica* (Hisinger), *L. Hisingeri,* sp. n., *L. Eichwaldi,* sp. n., *L. Wiluiensis,* sp. n., *L. parallela,* sp. n., *L. marginata* (Keyserling), *L. Keyserlingi,* sp. n.

Isochilina punctata and some *Primitiæ,* but no true *Leperditiæ,* have been yielded by the Lower Silurians of Russia. In the lower zones of the Upper Silurian, characterized by the smooth forms of *Pentamerus* (zones 4, 5, and 6 of the Esthonian series), *Leperditiæ* abound; *L. Hisingeri* occurring in all. In Gothland this species is found in zones 4 and 5; and *L. Keyserlingi* only in zone 5. The true *L. Balthica* is confined to Central Gothland. In Russia the limestones with smooth *Pentameri* contain *L. marginata*; and in Siberia *L. Wiluiensis*, *L. parallela*, and *Isochilina Maaki*. *Leperditia Eichwaldi* is met with between zones 7 and 8. In some localities *L. Angelini* is one of the most numerous of the fossils. *L. grandis* has been found near Lümmada, together with *L. Angelini*, and in the Uppermost Silurian of the Isle of Gothland. The same strata, with *L. Tyraïca* (a form comparable with the American *L. alta* of Conrad), exist along the Dnieper in Volhynia and Podolia.

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[1] "*Beyrichia,*" by inadvertence, in the former description.

[2] In the memoirs here referred to, "the Pentland Hills" are given by mistake, instead of *Peeblesshire,* as the locality.

Isochilina Biensis has been met with near Slatoust in the Upper Silurian, with *Pentamerus Baschkiricus*; and *Leperditia Barbotana* at a somewhat more northern locality, in a rock with *Leperditiæ* only.

T. R. J.

II.—Tabular View of the Classification of the Labyrinthodonta.[1] By L. C. Miall.

AMPHIBIA.

LABYRINTHODONTA.

A.—*Centra of dorsal vertebræ discoidal.*[2]—Genera 1 to 27.

I.—Euglypta. Cranial bones strongly sculptured. Lyra conspicuous. Mandible with well-developed post-articular process. Teeth conical; their internal structure complex; dentine much folded. Palato-vomerine tusks in series with small teeth. Short inner series of mandibular teeth. Sculptured thoracic plates, with reflected process upon the external border.

° *Palatine foramina large, approximated.*

† *Mandible with an internal articular buttress.*

‡ *Orbits central or posterior.*

1. Mastodonsaurus, Jäger.
2. Capitosaurus, Munst.
3. Pachygonia, Huxley (?).
4. Eurosaurus, d'Eichwald (?).
5. Trematosaurus, Braun.
6. Gonioglyptus, Huxley.

‡‡ *Orbits anterior.*

7. Metopias, Von Meyer.
8. Labyrinthodon, Owen.[3]

†† *Mandible without internal articular buttress.*

9. Diadetognathus, Miall.

°° *Palatine foramina small, distant.*

10. Dasyceps, Huxley.
11. Anthracosaurus, Huxley.

II.—Brachyopida. Skull parabolic. Orbits oval, central or anterior. Post-articular process of mandible wanting (?).

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[1] Presented to the Geological Section of the British Association at Belfast, August, 1874, by the Committee on the Labyrinthodonts of the Coal Measures.

[2] This character is not of primary importance, but seems to be available for an arrangement determined by other considerations.

[3] Orbits unknown.

12. Brachyops, Owen.
13. Micropholis, Huxley.
14. Rhinosaurus, Waldheim.
15. Bothriceps, Huxley.

III.—Malacocyla. Skull vaulted, triangular, with large postero-lateral expansions. Lyra consisting of two nearly straight longitudinal grooves, continued backwards as ridges. Orbits large, posterior, irregular. Temporal depressions, passing backwards from orbits. No post-articular process to mandible.[1]

* *Teeth with large anterior and posterior cutting edges.*

16. Loxomma, Huxley.

** *Teeth conical.*

17. Zygosaurus, d'Eichwald.

IV.—Athroodonta. Maxillary teeth wanting. Vomerine teeth aggregated. Orbit imperfect.

18. Batrachiderpeton, Hancock and Atthey.
19. Pteroplax, Hancock and Atthey.[2]

[V.—An uncharacterized group for the reception of some or all of the following genera.]

20. Pholidogaster, Huxley.
21. Ichthyerpeton, Huxley.
22. Pholiderpeton, Huxley.
23. Erpetocephalus, Huxley.

VI.—Archegosauria. *Von Meyer.* Vertebral column notochordal. Occipital condyles unossified.

24. Archegosaurus, Goldfuss.
25. Apateon,[3] Von Meyer.

B.—*Centra of dorsal vertebræ elongate, contracted in the middle.*

VII.—Heleothrepta.—Skull triangular, with produced, tapering snout. Orbits central. Mandibular symphysis very long, about one-third of the length of the skull.

26. Lepterpeton, Huxley.

VIII.—Nectridea.—Epiotic cornua much produced. Superior and inferior processes of caudal vertebræ dilated at the extremities and pectinate.

27. Urocordylus, Huxley.
28. Keraterpeton, Huxley.

IX.—Aistopoda. Limbs wanting.

29. Ophiderpeton, Huxley.
30. Dolichosoma, Huxley.

X.—Microsauria, *Dawson.* Thoracic plates unknown. Ossification of limb-bones incomplete. Dentine non-plicate, pulp cavity large.

31. Dendrerpeton, Owen.
32. Hylonomus, Dawson.
33. Hylerpeton, Owen.

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[1] Loxomma.

[2] The vomerine teeth are unknown, and this genus may therefore require to be removed.

[3] Of doubtful distinctness.

III.—GEOLOGY OF NEW ZEALAND.

ABLE OF THE SEDIMENTARY ROCKS OF NEW ZEALAND.

By Capt. F. W. HUTTON, F.G.S.

BABLE AGE.	FORMATIONS.	CHARACTERISTIC FOSSILS.
ISTOCENE	Alluvial Deposits..... O	*Dinornis, etc., Mactra rudis.*
VER IOCENE	Wanganui Formation O	*Pleurotoma Wanganuiensis, Chione assimilis.*
'ER IOCENE	Pareora Formation O ≡	*Buccinum Robinsoni, Struthiolaria, Cerithium rugatum.* *Corbula dubia, Turritella bicincta, Chione vellicata, Solenella australis.*
VER IOCENE	Ahuriri Formation O	*Struthiolaria tuberculata, Turbo superbus, Cardium spatiosum.* *Crassatella ampla, Pecten Triphooki, Ostrea ingens.*
'ER OCENE	Oamaru Formation O ≡	*Pleurotoma hebes, Scalaria rotunda, Struthiolaria senex.* *Panopæa plicata, Pecten Hochstetteri, Pecten Hutchinsoni.* *Waldheimia gravida, Terebratella Ganeteri, Hemipatagus formosus, Meoma Crawfordi, Schizaster rotundatus.*
UPPER TACEOUS	Waipara Formation O ≡	*Plesiosaurus, etc.* *Belemnitella, Conchothyra parasitica, Trigonia, Inoceramus Haastii.* *Aporrhais, Dosinia, Dicotyledonous plants. Dammara.*
DDLE JRASSIC	Putataka Formation ≡	*Belemnites Auclandica, Astarte Wallumbillaensis.* *Polypodium Hochstetteri, Tæniopteris, Alethropteris.*
VER URASSIC	Maitai Formation O	*Ichthyosaurus, Inoceramus, Spirifera.*
ASSIC	Wairoa Formation (?)	*Monotis salinaria. Halobia lomelli.*
ÆOZOIC	Kaikoura Formation	*Orthis. Corals, etc.*
	Tuamarina Formation	*Orthoceras, etc.*
	Wanaka Formation	Composed entirely of Crystalline Schists.
	Manipori Formation	

O Contemporaneous eruptive rocks occur in these formations.

≡ Coal is found in these formations.

IV.—JAHRBUCH DER K. K. GEOLOGISCHEN REICHSANSTALT. Wien, 1873. Band 23. Heft 2.

1.—*Geologische Studien in den Tertiärbildungen des Wiener Beckens.* [16.] *Ein geologisches Profil aus der Bucht von Berchtoldsdorf.* (pp. 117–132.) By FELIX KARRER.

The sinking of six wells in a continuous line has shown clay alternating with "Leitha-conglomerate." Samples from both beds were examined for organic remains in each sinking. Foraminifera constitute the bulk of the lists and their degree of abundance in each case is very carefully set down, and finally embodied in a table.

[17.] *Das Alter des Rohrbacher Conglomerates.* (pp. 132–136.) By FELIX KARRER.

Excavations for the foundation of a bridge have shown that this conglomerate rests on a clay, in which the author found the following Foraminifera: *Nonionina granosa*, *Polystomella obtusa*, and *Hauerina*. These prove that the clay belongs to the "Sarmatic" horizon; hence the conglomerate is newer than the Leitha-conglomerate, and may possibly belong to the Congeria-beds. E. B. T.

2.—*Beiträge zur topischen Geologie der Alpen der Rhaetikon (Vorarlberg).* (pp. 137–174, with a geological map and plate of sections.) By DR. ED. VON MOJSISOVICS.

In referring to the break produced in the Trias deposits by the Rhine valley, the author argues against the notion of their having once been present on both sides of the valley, and their absence on the west side being due to dislocations and denudation. He infers that this line marks rather the original boundary; and points out the transgressive character of the Trias deposits on the east side, and again that on the west side the Verrucano (Dyas) is overlain by Lias; moreover, in the Vorarlberg, the strike of the Trias beds, which in the eastern district has been mostly east and west, verges round to an almost north and south direction. This paper, besides new facts, contains many suggestions on theories of Alpine elevation.

E. B. T.

3.—*Der Graptolithen-Schiefer am Osternig-Berge in Kärnten.* (pp. 175–248.) By DR. GUIDO STACHE.

Controverts views of Prof. Suess, according to which certain mica-schists and granites which occur in them (*e.g.* Cima d'Asta granite) are all of Carboniferous age; these schists being by him grouped as Casanna-schists, and placed above the Carboniferous beds of the Stangalp. Stigmatizes these assertions as too speculative, and shows that the Casanna-schists instead of being simply Upper Carboniferous, contain other and much older beds, probably in the Casanna district, and indubitably in the Gailthal. The Graptolites found in schists at Osternig-Berg show beds of the age of the Coniston flags. The Upper Silurian is also represented, as shown by fossils; and ove are more schists, which may perhaps be Devonian. The ystalline schists of the Gailthal, erroneously attributed to the rboniferous, are in an unconformable position below the older eywacké, which last far surpasses the Carboniferous beds in portance. E. B. T.

—[Heft 3.] I. *Ueber das Verhältniss der böhmischen Steinkohlen- zur Permformation.* (pp. 249–282, with a plate of sections.) By Dr. O. Feistmantel.

Notices the occurrence of workable coal-beds in Bohemia of ermian age. The lower part of the series contains the coal-seams, it both the upper and lower beds contain plants usually considered pically Carboniferous, e.g. *Stigmaria ficoides, Sigillaria alternans, ethopteris Serlii, Pecopteris arborescens, dentata,* and *oreopteridis, phenophyllum Schlotheimii, Calamites Suckovii,* etc., mixed with some ermian plants. The Permian coal-beds are separated from the rboniferous beds below by shales with characteristic Permian imal remains. These Bohemian lower Permian beds may be ralleled according to our author with the beds containing *Archego- urus* in the Saar and Rhine district, which he also considers Dyas, d which lie upon the true Saarbrücken Coal-measures. E. B. T.

—*Basalt-Vorkommnisse in Mährisch-Ostrauer Steinkohlenbecken.* (pp. 282–288, with a map.) By J. Niedzwiedzki.

Eruptive dykes occur in the coal-basin of Ostrau (Moravia), and ve in one case turned coal into columnar coke. The rock has the tward characters of Basalt, and microscopic examination confirms is determination. E. B. T.

—*Ueber das Vorkommen tertiärer Bildungen im oberen Marizathal.* (pp. 289–294, with a sketch-map.) By Anton Pelz.

A contribution to the geology of the country between the Balkans d Mount Rhodope. Tertiary beds, Nummulitic, etc., had not been oticed before in this basin. E. B. T.

—*Beiträge zur Geologie der Fruska Gora in Syrmien.* (pp. 295–316.) By Dr. Oskar Lenz.

The Fruska Gora is one of a low chain of hills that rise out of the lain between the rivers Save and Danube, near the fortress of Peter- ardein. The nucleus of the range consists of crystalline schists, terrupted by two principal bands of serpentine. The Trias is very parsely represented, and the Jurassic beds not at all. Tuff beds, ntaining Upper Cretaceous fossils, of Gosau type, are the next age met with. Then follow fossiliferous and lignite-bearing beds f Aquitanien age, one bed of coal being 9ft. thick. Above come eitha-conglomerate, Sarmatic, and Congeria-beds, as in the Vienna asin, some being very fossiliferous. E. B. T.

REVIEWS.

I.—A BURIAL PLACE OF THE ANCIENT CAVE-FOLK OF THE PYRENEES, OVERLYING HEARTH-STUFF CONTAINING HUMAN REMAINS, ETC. By LOUIS LARTET and CHAPLAIN DUPARC. (Une Sepulture des anciens Troglodytes des Pyrénées, etc.) 8vo. pp. 67. (Masson, Paris.)

THE study of Prehistoric Archæology is one of comparatively modern origin. As a distinct branch of scientific research, it is only within late years that it has attracted notice, chiefly, perhaps, because of the previous want of that tangible evidence afforded by actual discoveries of human life and handiwork which have, since the beginning of the century, been yearly increasing in number, and more earnestly and persistently studied.

The pamphlet written by MM. Lartet and Duparc furnishes us with another most valuable addition to our literature on the subject; valuable, not merely because of the actual detailed information given us, but because the authors have given their reasons for considering the deductions, as to the history of these early races, trustworthy and sound.

The opponents to the theories supported by M. Lartet have seized with avidity any facts that could support their own hypothesis. Dr. Schliemann's discoveries in the Troad, where stone implements were found with ornaments and figures of a high type of art, have led them to bring the "Stone Age," and hence that of "Cave Man," within historic times.

It is justly asked by our authors why, if such be the case, should the valleys of Syria and Phœnicia contain both undoubted traces of prehistoric habitations, and weapons identical in type and character with those employed by the old hunters of Aquitaine, and equally recognized remains known to be of a far later date?

Science is, after all, but "facts generalized"; and the arguments in favour of such a view as the authors advocate are based, as they clearly assert, on facts on which a theoretical superstructure is erected,—a vastly different thing, be it remembered, from an hypothesis founded on possibilities only. Still, the question is undoubtedly discussed in general from two exaggerated grounds; one side boldly, but somewhat rashly, placing the appearance of man far back into the Tertiary geological period; the other insisting that our history and our traditions fix the exact limit of his early existence.

Taking (say our authors) as a fair assumption, that man *could* exist in the Miocene period, inasmuch as both fauna and flora are types of those existing at the present time, it is only necessary to recognize that a change of temperature and alterations in the relative level of land and sea, of which there is sufficiently good evidence, not even questioned by the opponents to the theory of the existence of pre-historic races, would at once provide the conditions under which these races could have lived.

The facts on which the theory of the very early existence of man-*d is* based appear to be these (page 6, etc.).

1. The drifted materials, called "Quaternary" or "Diluvial," and contemporary with the gradual excavation of our valleys, contain instruments of flint, the work of human hands.

2. After the formation of the valleys and the sinking to nearly their present level of the waters that had formed them, and before the extinction, or the emigration to colder climates, of the flora and fauna which characterize the Quaternary period, the caverns in these valleys were occupied by a race of hunters, who used for arms and implements worked bone or fragments of flint. Later in their history, their implements are found engraved with sufficiently faithful representations of the animals they pursued in the chase; but apparently the potter's art was unknown to them.

3. After the occupation of the caves and rock-shelters by these reindeer-hunters, and the extinction or emigration of the animals on which they lived, a race more advanced in civilization took possession of them, and left, in the fragments of pottery and instruments of *polished* stone, traces of a higher degree of civilization.

4. This race was followed by others, who built the Megalithic monuments ascribed to Druidic worship, and who, in burying their dead, whether in caverns or otherwise, raised tumuli of earth, or cairns of rough stones, to mark their primitive sepulchres. These races were migratory in their habits, and followed from north to south the coasts of Western Europe. While still using stone for their implements, they, through contact with the more highly civilized nations of the southern seas, were enabled to procure bronze, which was, as a general rule, fashioned into ornaments only.

5. This metal speedily, whenever practicable, replaced the ruder implements of stone; but the quantity to be procured varied so considerably with the locality, that in many places it was looked on as too valuable for weapons; and, as a rule, stone continued to be the chief source of supply for hard tools or weapons.

6. Finally, towards the end of the previous "age," that is to say, when bronze, by commerce or by actually a more advanced stage of civilization, became more generally used, there appeared on the slope of the Alpine ranges races who used swords of iron; and from that time forward bronze took a secondary position, and iron became the material for the arms of the warriors. This brings us down to historic times, and we have passed from the men who probably saw in activity the volcanic mountains of Auvergne, or the great glaciers of the Jura and the Vosges, to the Gaul, who threw his iron sword into the balance which weighed the ransom of Rome.

It is difficult, we may remark, to indicate any distinct line of demarcation between these different periods. Necessarily in later times the exchange of materials became the earliest type of commerce. But it seems impossible to imagine that these successive and sufficiently distinct traces of life should be that of one and the same race. In the struggle for existence in early times the extinction or emigration of animals, and consequent disappearance of the means of livelihood, would naturally lead to a change of locality of races *who used them for food.* The difference of level at which the relics are found, the superposition of different types of implements, must surely prove something; and it is, to say the least, unnatural to assume that a race of low civilization would persist in remaining in a neighbourhood deserted by the animals on which it lived, and alter at once its habits, its weapons, and its life.

Nor is it easy to fix the precise line of demarcation between these Troglodytic races and those who, more advanced in civilization, constructed the Dolmens and the Tumuli of France or Iberia. Only more extended research—a more complete collection of facts—can do this. So far, we only know that the caverns, such as those described in M. Lartet's brochure, contain chiefly stone or bone, as characteristic of the "Troglodytic race;" while the succeeding, but still archaic, "Dolmenic" race can now be identified as distinct from the next ("Tumulic"), or those whose places of sepulture are indicated by tumuli only, by the fact that they formed ornaments of bronze, and weapons of stone rather than weapons of iron.

The discoveries which form the subject of the elaborate and well-illustrated pamphlet before us consist of a series of caves, with evidences of human existence, which occur near Sorde, at the base of the escarpment of Nummulitic Limestone forming the peninsula separating the Gave de Pau and the Gave d'Oloron, the principal affluents of the Adour. The main limestone ridge presents indications, in tumuli and entrenchments, of early occupation, both by the Romans and by races far anterior to them; but the remains found therein are of far later date, and present a much higher type of civilization, than those discovered in the more primitive dwellings at the foot of the high defensible land.

The caves, as far as the present researches have extended, are five in number; the first three having been opened by M. Raymond Pottier in 1872–3, and the fourth and fifth since that date. The last—described by MM. Lartet and Duparc as the "Grotto Duruthy," after the proprietor of the land—was the richest in remains, and forms the subject of the memoir.

In each instance the hollows were natural cavities under the overhanging rock, and, though, from the pile of débris accumulated outside them, it is possible they were once larger, that is to say, before the front edge of the superincumbent mass had crumbled or broken away, they must have been of small capacity; and now the Duruthy Cave measures only about 25 to 30 feet by 6 feet.

The great value of this pamphlet lies in the very complete manner in which well-authenticated instances of the mode of life of existing races are introduced to give means of comparison, and basis for theoretical discussion.

J. G. Georgi's book, published in 1776, descriptive of the various races forming the vast Empire of Russia, is quoted to furnish us with descriptions of the life and habitation of the nomadic and barbarous tribes that, subsisting by reindeer-hunting and fishing, line the coasts and inlets of the Northern seas.

Finns and Wogouls, Tchouktsches and Kamschatsdales, living by hing and the chase, inhabit frequently mere caves and hollows in e rocks, before which they hang the skins of reindeer; and hich they furnish, as well as they can, with driftwood, skins, and ats. Their arms are sharpened stones, their arrows, and lances inted with cut bones of animals or the sharp bones of fish. Some en of the Esquimaux and Tchouktsches carve on the teeth of imals sketches of the products of the chase, and share, with all milar races, the habit of fracturing the bones to extract the marrow.

Such undoubted evidence as this supplies matter for reasonable mparison for the caverns of Sorde. There, too, is an equal absence metal as a material for weapons. There, too, the bony fragments ar on them "owner-marks," and sculptures which, though roughly ecuted, are definite and clear. There, again, flints, worked into tistic shapes in some instances, and roughly broken to form scrapers lance points in others, are sufficiently plentiful.

That generations, or even perhaps races of Troglodytes have inabited these countless excavations of Sorde, is evident from the yers of burnt ashes and reddened earth marking the sites of res; between which are the gradual accumulations of soil and efuse, the result of the decomposition of the limestone rock and ther natural causes. The successive inhabitants, too, seem to have een singularly incurious. Rarely have the lower remains been dis-rbed by the later people; and where they have been moved, the resence of bones and skulls of foxes, which to the present day ake their burrows in these hollows, is enough to account for the ccasional irregularity of the deposits. This more particularly pplies to the human skeletons which in the higher levels of ac-umulation were so numerous as to show that the final utilization of e caves had been for sepulchral purposes.

The lower stratum contained the most interesting relics; for about fty teeth of the Lion and Bear were found, all of which were ierced for stringing, and marked either with lines in continuation f the fissures in the enamel, or by zigzag, cuneiform, sagittate, or ther marks. Mr. Lartet attributes no especial meaning to these arks, signs, or ornaments, but notices the symmetrical position of ome as pairs, one on each side of the tooth.

Whether rough attempts of the draughtsman in his first effort at ombining the straight lines easily made by a rough flint tool, or, as uggested by Professor T. Rupert Jones, F.R.S., in his exhaustive aper on such markings,[1] indications of ownership, tallies, or ambling marks, similar, in themselves unmeaning, marks are found n the tools and weapons of existing Northern races. Sufficiently istinct outlines of Pike and Seal are boldly cut on two of the ear's teeth; and, curiously enough, there are on the sides of one oth roughly executed drawings of hands encased in mittens, imilar to those of the reindeer-hunters of Perigord, or, to compare hem with existing types, of the same kind as those worn by Esquiaux and others, who, as hunters of seal and deer, inhabit the orders of the frozen seas.

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[1] "*Reliquiæ Aquitanicæ*," livr. xiii., p. 183, etc.

The second definite layer, on which were traces of fire, contained bones of Ruminants, especially Ox, Deer, and Reindeer, with a few bones of the Horse; while the worked flints were of the types found at la Madelaine and Laugerie rather than in the more ancient caves of Le Moustier and Cro-Magnon.

As time went on, the lower part of the cave became filled with débris, until it could no longer afford sufficient shelter; and the mere niche now left was used as a place of sepulture. Relics of more than thirty bodies were found in the further part of the excavation; and, from the Dolichocephalic type of the skulls, they appear, at first glance, to be coeval with those of Cro-Magnon; but the fact of the bone ornaments being carved with representations of animal life, and so forth, would at once put them as of more recent date than those remains. The bone implements were such as are classed under the "polished stone age." The flints were of two kinds,—one of a rude and early type, mere flakes or scrapes; the others highly finished and, to a limited extent, polished, being by no means inferior in workmanship to those discovered in the "long barrows" of Cumberland and Yorkshire.

It does not follow, therefore, that the lowest strata and the place of burial contain relics of two separate races; that, in fact, successive and distinct waves of population have swept over the valley of the Adour. The nature of the superposition of the successive habitations would rather tend to show that the ancient inhabitants of the caves of the Sorde peninsula were but different branches of the same race, and that the descendants of those who sculptured bear and lion's teeth, when the caverns were places of habitation, were the ancestors of those who had lingered on to the days when the implements of flint were made beautiful in form and artistic in workmanship (fig. 25).

The pamphlet completely bears out this assumption, and the number and careful nature of the illustrations furnish us with accurate data for the consideration of the theory so ably advanced and so completely discussed by MM. Lartet and Duparc.

C. Cooper King.

II.—Report upon the Palæontology of the Province of Ontario. By Prof. H. A. Nicholson, M.D., F.R.S.E., F.G.S., etc., etc. 8vo. illustrated, pp. 130. (Toronto: 1874, Hunter, Rose, & Co.)

In this Report Prof. Nicholson describes, and for the most part figures, the fossils that he collected during the year 1873, in the Devonian rocks of Western Canada; and in this work he has been aided by a grant from the Government of Ontario.

The specimens described come mostly from the Lower Devonian series (Oriskany Sandstone and Corniferous Limestone), but the Hamilton Group was also examined.

Altogether 160 species are described, viz.:—Protozoa, 6 species; Cœlenterata, 70; Brachiopoda, 43; Polyzoa, 20; Lamellibranchiata, 1; Pteropoda, 1; Gasteropoda, 12; Annelida, 3; Crustacea, 4. Some of these have already been described and figured by the author during the present year in the Geological Magazine,[1] whilst many are referable to species which have been previously described by various authors in different publications.

The following seventeen species are, however, altogether new, having never before been described in any work, viz.:—*Heliophyllum prolificum*, *Syringopora intermedia*, *Productella Eriensis*, *Leiorhynchus Huronensis*, *Fenestella magnifica*, *F. marginalis*, *F. filiformis*, *Platyceras uniseriale*, and two other species of *Platyceras*, too fragmentary to be definitely determined, *Strophostylus* (?) *sub-globosus*, *S.* (?) *ovatus*, *S. obliquus*, *Holopea Eriensis*, *Helicotoma serotina*, *Spirorbis Arkonensis*, and *Ortonia intermedia*.

The work is abundantly illustrated with woodcuts, and there are eight plates besides, in which are figured the more important specimens and some of the new species.

All the illustrations are well executed, and would have shown much better had they not, through some mistake of the printer, been printed on an inferior quality of paper. With the exception of two of the woodcuts, all the figures are original.

By the publication of this report, Dr. Nicholson, who has already contributed so much to our knowledge of Canadian palæontology, has laid us under a yet further obligation; the book will doubtless be highly acceptable to all who are interested in American geology.

REPORTS AND PROCEEDINGS.

Geologists' Association, London.

Henry Woodward, Esq., F.R.S., President.

Excursion to Cheltenham.

The London Geologists' Association made their Midsummer excursion to Cheltenham; and, at the suggestion of the President and Secretary, Dr. Wright, F.R.S., was requested to draw up a programme for five days and undertake the direction of some of the excursions.

On the arrival of the party on Monday, the 20th July, they were conducted to the School, near the Station, and partook of a substantial lunch,—time not permitting them to go into the town,—and at three o'clock they again took the train for Churchdown. Dr. Wright's object was to give the members a physiographic picture of the Severn valley. He first guided them to the summit, and explained the western side of the panorama from the Abberley Hills in the north, along the Malvern chain in the west, and the May-hill and Dean Forest on the south-western horizon; he pointed out the structure of these hills, which give a key to a right understanding of the varied features of the surrounding country. The valley next engaged the attention of the Director; he pointed out the area occupied by the Keuper beds and the Lias, and indicated the limits of this formation high up in the escarpment. He then showed that Robin's-wood Hill, Churchdown Hill, and Bredon Hill, were three islands, or *outliers* from the main chain, and were conclusive evidence that the Cotteswold range had extended as far as these hills did into the vale, and that the horizontal valley running between the Cotteswolds and Churchdown, and the other outliers, with the transverse valleys running between them, had all been caused by the wasting denudation that had been going on through vast periods of time. Dr. Wright said he had purposely brought them to Churchdown to give them one of the most telling lessons he could select to illustrate the great truth that atmospheric agents supply the chisels by which the solid rocks are sculptured, whilst rain, frost, and snow carry on the work of destruction wherever they are exposed to these agencies.

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[1] See Geological Magazine, January—April, 1874.

Turning to the eastern view, the chain of the Cotteswolds presented a splendid picture, both as regards outline and colour, when seen from the old rampart on which they stood; and the Director here pointed out the remarkable difference the opposite sides of the valley presented, the angular summit of the Malverns finely contrasting with the rounded swelling summits of the Cotteswolds. A long discussion now took place touching the various points of geological interest, and explanations and illustrations were asked and freely given. After visiting the church, the party returned to the vicarage, where the Rev. Mr. Smithe kindly refreshed the party with hospitable cheer, and showed his collection of fossils from the neighbouring hill.

July 21st.—Leckhampton Hill was the object of this day's excursion. The party assembled at the windlass at eleven o'clock, and then, punctual to time, the Director of the day, Dr. Wright, F.R.S.E., commenced his address. He had laid out on the grass several large sections and maps of the hill, and proceeded to point out first the connexion between the subjects referred to yesterday and those which had to be studied to-day.

He said the Oolitic system of rocks formed a most interesting study both as regards structure, origin, and organic contents. The system consisted of three great argillaceous formations, the Lias, the Oxford-clay, the Kimmeridge-clay, and three systems of Oolitic limestone rocks superimposed on them—the Lower Oolite resting on the Lias, the Middle Oolite on the Oxford-clay, and the Upper Oolite on the Kimmeridge-clay. The great argillaceous deposits had been deposited under special relations, and the Oolite Limestone under totally different conditions. The one had formed the shore of a wide ocean; the other was produced by the growth, decay, and reconstruction of Coral Reefs in the Jurassic Sea. In the argillaceous seas sported the great *Ichthyosauri*, numerous fish, and Ammonites in abundance; and in the Coral formations the Molluscs, Sea-urchins, Corals, and Crinoids that lived in such localities, and have left abundant remains in the limestone rocks, some beds of which are composed entirely of organic remains.

He described in detail the sands that lie between the Upper Lias Clay and the Inferior Oolite, and which at Frocester Hill contain a remarkable fossiliferous bed full of Ammonites and *Belemnites* which were imperfectly represented here. Then the

"Pea-Grit," with its first Coral Reef, at Crickley Hill, was next described. Then the Freestones and Oolite Marl with a second Coral-bed found therein; and, lastly, the Upper Ragstones and third Coral-bed.

Dr. Wright handed round some of the leading fossils of each of these beds, and gave a detailed description of them. The *oolitic* or '*roe*'-structure of these rocks had long engaged the study of naturalists, and lately he had read a paper to the Cotteswold Club at Bath on the genesis of the Oolites. He said he regarded all Oolitic Limestones as the product of Coral Reef builders, either in the form of fossil reefs as that specimen in his hand, or as the débris of Coral which had been rubbed down into coral mud, and re-arranged along the coral strand in the form of Oolitic grains, for it was only along the shores of coral islands that Oolitic structure was discovered among modern formations, for reef-building corals can only live and work in water having a temperature of 80° to 82°, and that condition is now chiefly found between 30° north and south of the equator. Their operation is for the most part confined within those limits ; while even in those latitudes where the ocean is traversed by cold currents, there zoophytic life is absent.

Dr. Wright then explained how, in certain areas of the earth's surface, one portion is subsiding whilst another is rising, and observation had proved that the region of the coral sea of our time is a vast area of depression, and that as the life-conditions within that area were most favourable to the development of polyps, there was a prodigious amount of Reef-building going on. When they built around a shore, it formed a fringing reef; when that ground became depressed, a barrier reef was formed, which encircled the island; and when the land became finally submerged, rings of coral or "Atolls," like Whit-Sunday Island, were formed, and alone remained to attest the former existence of *terra-firma.* He pointed out that when a Reef breaks up, the rock is reduced to a fine mud or into coralline sand, and that this calcareous paste coats fine particles of sand, and that these particles, having been rolled to and fro by the swell of the ever-restless ocean, such a motion is imparted to the grains that Oolitic limestones are thus formed around the shores of the coral islands of our day. Having thus established the fact that Oolitic limestones are produced under these conditions, he proceeded to apply this to explain the origin of the Oolites now under consideration. Nearly all Oolitic limestones contain Coral Reefs. There were three superimposed in the Lower Oolite, one in the Great Oolite, another in the Forest Marble, several in the Coralline Oolite, and one certainly in the Portland Oolite. These Reefs were the undoubted products of Zoophytes, and when the Reef, which had grown to perfection and life in it, had ceased, that calcareous mass became disintegrated and rubbed down to mud, and this mud became the paste out of which beds of Oolitic limestones were formed. This theory enabled us to explain the remarkable cross-bedding in many Oolitic quarries, and likewise as coral limestones might have been piled up under subaërial *conditions along* the shores of islands, their great thickness in some localities, as in the hill above them, and their thinness in other localities at small distances apart, received a satisfactory explanation by adopting the view that the genesis of the Oolites was due to the vital energies of Zoophytes that lived in the Jurassic seas.

The reefs that remained were mere fragments of those which had once existed, and the calcareous masses that had disappeared as reefs had furnished the material out of which all Oolitic Limestones were formed. The same explanation applies to the oolitic beds found in the Carboniferous Limestone which had been formed out of the waste of the coral beds of the Carboniferous sea; in a great many of these Carboniferous oolitic grains he had found the microscopic shells of *Foraminifera* which had served as the nucleus of the particle: thus the presence of a calcareous paste and the incessant roll of the ocean along a coral strand were the elements and physical conditions under which the Oolites were produced.

A description of the beds *in situ* followed the lecture, on which an interesting discussion ensued until lunch was announced, and so the party repaired to Major Barnard's, at Bartlow, and enjoyed a solid repast. The valley looked more beautiful than ever to-day from the hill, and many an exclamation told how the scene had impressed itself upon the geologists. After lunch the party went over the upper beds, and walked through Hartley-bottom to the Seven Springs, to see the source of the Thames.

July 22nd.—May Hill or Yartleton was the excursion to-day—Mr. J. Logan Lobley, F.G.S., acting as Director. The party took train to the Longhope station, and walked from thence to the summit of May Hill, 972 feet above the sea.

The view from the summit is magnificent; looking to the N.N.W. one sees the dome of Woolhope Forest in the line of the axis of the hill on which one stands, and to the N.N.E. the Malverns are seen beyond a long line of fracture and unconformity with outcrops of Coal-beds; between these two lines the trough is filled in with Old Red Sandstone; to the South the eye follows the group of hills gradually contracted by the approach of the Red Rocks, till at Flaxley the May Hill ridge terminates. The distant Cotteswolds have a picturesque effect when seen from the summit, and the Forest of Dean with its reeking chimneys tells us of the iron and coal industries that are there at work. The structure of the Hill was explained by the Director, with the aid of maps and sections, and the quarries of Llandovery rocks (May Hill sandstone), Woolhope Limestone, Wenlock Limestone, and Lower Ludlow Rocks were ransacked and yielded some fine specimens to the knights of the hammer.

July 23rd.—Garden Cliff, near Westbury-on-Severn, was the rendezvous for the day, and Mr. W. C. Lucy, F.G.S., the Director. The party went by train to Grange Court, and walked from thence to the Cliff, a distance of four miles. Garden Cliff is one of the most typical sections of the *Avicula contorta* beds, a series of deposits which contain a well-marked set of fossils, and are interposed between the lowest beds of the Lias and uppermost beds [illegible] the Keuper; they indicate a great change in the physical geograıy of the earth whilst they were being accumulated. The shells ·e all small, and appear to have lived in brackish water. In these ›posits the remarkable bed known as the "Aust Bone Bed" is ·und. This section can be so admirably studied at Garden Cliff, ıd each bed in succession taken as it rises on the shore, that it has ›ng been the favourite haunt of the geologist. After demonstrating l the beds, the Director embarked his party in three tubs of boats, ıd, at the risk of shipwreck, the passage of the Severn was accomlished, and dry land regained. Mr. Lucy showed them the Lias at retherne, and its relation to the other beds in the valley, and they ›ached the Berkeley Canal in time for the steamer's return from harpness. They dined at Gloucester and returned home by the).30 P.M. train, having enjoyed a pleasant day, although they had tempted rather more than they could compass with ease and lvantage.

July 24th.—Tewkesbury, Deerhurst, Wainlode Cliff, and Apperley ourt, formed this day's excursion; Directors, the Rev. W. S. ymonds, F.G.S., Mr. James Parker, F.G.S. (Oxford), and Dr. /right, F.R.S.E. The Abbey was described by the Vicar, who ›ad a short paper on some of its leading features, and the historical art of the subject was critically examined in a masterly way by Mr. arker. After a stroll through the building, the party were invited › meet under the Grand Norman Arch, and Mr. Taut, Photographer, f Oxford, succeeded in taking a good picture of the group. From ıe Abbey, the walk was over the Battlefield to Tewkesbury Park, here Mr. Sargeaunt refreshed the party.

Mr. Symonds gave an address on the historical associations of the round around them, and the party then drove to Deerhurst Church, here Mr. Parker ably described this fine edifice, the dedication one of which (1002) is now preserved in the Oxford Museum.

The party now proceeded to Wainlode Cliff, to see another section f the *Avicula contorta* beds. Dr. Wright gave a demonstration of ıis section from the Severn bank, and brought together the details f the various sections of the same beds they had seen to-day at oombe Hill, and yesterday at Garden Cliff. He described the ossible conditions under which they were deposited, and the great hysical change coming over the region in which they are found. 'hey indicated the dawning of the Jurassic epoch, and the shores of ıat ocean in which the Saurian monsters of the Secondary age first ıade their appearance on our shores. The geologists made some ood finds in the bone bed. The party then returned to Apperley ourt, to enjoy a sumptuous dinner, to which the members of the .ssociation had been specially invited by Miss Strickland, the lady f the domain, who received the members in her usual genial appy manner. Several friends and neighbours also had now ›ined the gathering. After the banquet, speeches were delivered by ir W. Guise, the Rev. W. S. Symonds, and Mr. Jones, of London, ılogizing in warm terms the Strickland family as promoters of 'atural Science. Mr. Symonds described the Mammalian remains collected by the late Hugh Strickland, Esq., and preserved in the hall. This was followed by an address from Dr. Wright, "in memoriam" of his working with the late eminent Hugh Strickland in the Lias zones of the neighbourhood, and on the Cotteswolds. A cordial vote of thanks was given to the Directors, and another vote to Miss Strickland for her hospitable reception and entertainment, and this brought to a close the day's proceedings, and the week's programme of the visit of the London Geologists' Association to Cheltenham and its neighbourhood.—*Cheltenham Free Press, August* 1, 1874.

CORRESPONDENCE.

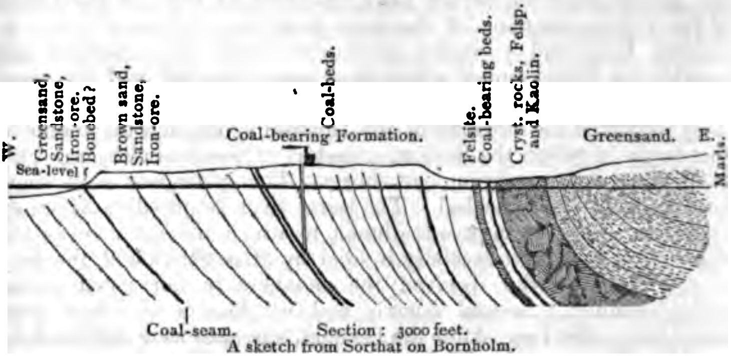
SCANIA AND BORNHOLM.

Sir,—Doubts are entertained as to the precise age of the Coal-bearing formation in Scania, mentioned in your September Number of the Magazine. On Bornholm—a Danish Island in the Baltic—is the same formation, and here I found several years ago *Pentacrinus scalaris*, Miller, but only once; neither Forchhammer nor any other author has mentioned this fossil from our localities. To be sure the "Bone-bed" may be here, if we have both Trias and Lias.

Allow me to add that this Coal-bearing formation has a thickness of probably 2000 feet; the strata dip frequently at very high angles, and so the faults are sometimes large; the Coal-seams or beds, about twenty in number, vary from a few inches to 8–10 feet, some of which are worked.

The Coal-bearing formation is overlain by crystalline, eruptive masses of Felsite, Granite, Breccia, Gabbro, etc., followed by Cretaceous beds of Greensand, all conformable, as described by me in "Natürhistorisk Tidsskrift," 1867 and 1869.

Volcanic action has here taken place after the age of this Coal-bearing formation and before that of the Greensand.



A sketch from Sorthat on Bornholm.

Dislocations succeeded the Greensand, and I should venture to suggest following three directions with an angle of 120°.

Ha despudin u pakr puda. **M. Jespersen.**

Rönne on Bornholm, Oct. 4, 1874.

THE

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No. XII.—DECEMBER, 1874.

ORIGINAL ARTICLES.

I.—The Mechanism of Stromboli.

By G. Poulett Scrope, F.R.S., F.G.S.

Mr. R. MALLET—whose theory on the source of volcanic heat was noticed in a former number of this Magazine—has followed it up by a second paper, read before the Royal Society in June last, and published in the last number (155) of the Proceedings, upon "The Mechanism of Stromboli," one of the Lipari Islands, well known for the permanence of its volcanic activity, which seems to have been incessant for the last two thousand years at least. This insular and conical mountain rises more than 3,000 feet above, from a depth of nearly 2,000 feet below, the level of the Mediterranean, and exhibits the usual structure of a volcano, having an old breached crater on one side, from the bottom of which red-hot scoriæ and fragments of lava are thrown up, together with much steam, by explosions occurring at irregular intervals of from two or three to thirty or even occasionally forty minutes.

Stromboli has been visited and its phenomena described, with the most careful and precise accuracy, by many geologists of the highest eminence, whose descriptions Mr. Mallet, *more suo*, dismisses contemptuously, as neither full nor accurate (p. 497). To any one, however, acquainted with the history of Geological Science, especially of that portion of it which deals with the phenomena of volcanic action, the names of the distinguished observers given below will be a sufficient guarantee for the value and truthfulness of their accounts. And a reference to their writings will show how clearly and conscientiously these accounts are given.[1]

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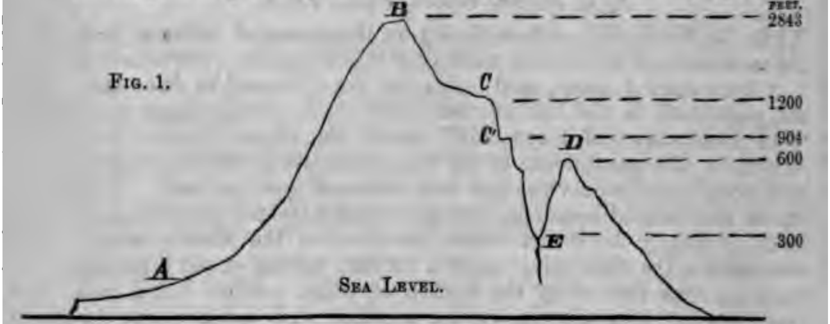
[1] 1768. Sir W. Hamilton with Signor Fabris.
1766-81. Stromboli seen twice by Dolomieu.
1781. 19th and 20th July, ascent by Dolomieu.
1788. 20th of August, 1st and 4th October, Spallanzani.
1810. Francesco Ferrara.
1813. Several visits by Admiral Smyth.
1819. May, G. Poulett Scrope.
1824. Dr. Daubeny.
1825. M. Biot.
1829. M. Virlet and the Members of the Commission visiting the Morea.
1831. M. Constant Prevost.
1831(?-2). Friedrich Hoffmann studied Stromboli during three weeks. Three ascents, December 21st, etc.
1836. 24th and 25th July. H. Abich collected and examined its products.
1844. June. MM. de Quatrefages, Edwards and Blanchard.
1855. May, June, and October, } M. Charles Ste.-Claire Deville.
1856. July, }
1866. M. Fouqué.
1867. M. Jansenn. 1870. Dr. Julius Schmidt.

Mr. Mallet's own observations are obscured by a singular amount of incorrectness in the measurements given by him as taken with the aneroid, which not only err to the extent of more than a hundred per cent., but are also wholly inconsistent with the sectional diagrams by which the text is illustrated. Lest I should be supposed rashly to dispute Mr. Mallet's professional ability in the measurement of heights and the construction of diagrams, I annex an accurate copy of his principal diagram representing the island, with the heights as given by him in the text placed alongside (Fig. 1).

FIG. 1.



A glance at this figure is sufficient to show that, if Mr. Mallet's estimate of the extreme height of the mountain, viz. 2,843 feet, be correct (the English and French Admiralty Charts, however, give it at 3,090 feet), all the other heights in the diagram *must* be at least 1,000 feet below the truth;—the point C, for example, being visibly about three-fourths of the whole height of the mountain, and therefore about 2,143 feet, instead of 1,200, which Mr. Mallet says he found it. All the lower points are in error to the same amount or more. Mr. Mallet's diagram, however, is not so far wrong as the measurements given in his text, since the best authorities concur in stating the height from the sea of the upper lip of the crater (C in the diagram) as about 2,200 feet, instead of 1,200 only, which Mr. Mallet assigns to it. It might be supposed that the several heights given in the text are, by a typographical error, made 1,000 feet less than the author intended. But this is inadmissible, not only on account of their number, but because (as will be shortly shown) Mr. Mallet's whole theory hangs upon the proximity of the bottom of the crater, marked E, to the sea-level, estimated by him as only 300 feet in vertical distance, whereas in fact it is nearly if not quite 2,000!

In correction of these errors of Mr. Mallet, I give the following from the highest authorities:—

EXTREME HEIGHT OF THE MOUNTAIN.

By French Admiralty Chart (Dumondeau)	942 mètres	(= 3,090 feet).
By English Admiralty Chart...		3,090 feet.
By Italian Government Map...	921 mètres	(= 3,022 feet).
By Hoffmann (Barometrical measurement) confirmed by Abich	2,775 German feet	(= 2,853 English feet).

The latter measurement agrees, it will be seen, very closely with *that* of Mr. Mallet; not so the following, which is far more im[illegible]rtant, having a direct bearing upon the structure of the mountain, d especially on Mr. Mallet's theory of its phenomena.

HEIGHT OF THE LIP OF THE CRATER (presumably Mr. Mallet's point C in Diagram).

Hoffmann (by Barometrical measurement) 600 feet below the summit	**= 2,253 feet above the sea.**
Abich (from repeated measurements) 2,178 German feet ...	**= 2,239 English feet.**
(Mallet, by aneroid measurement and estimate	**1.200 feet !)**

Taking then 2,245 feet (the mean of MM. Hoffmann and Abich's figures) as the true height of C in Mr. Mallet's Diagram, and admitting his own estimate of 600 feet as the vertical difference between C and D, it is seen that the height of the latter point cannot be less than 1,650 feet, instead of 600, which Mr. Mallet makes it. While, if we accept the measurement of the several Government Charts for the summit of the mountain, 245 feet must be added to 1,650, making about 1,900 as the true height of D from the sea.

The relative heights of the summit and lowest crater rim (D in Diagram) are seen in the drawings attached to the English and French Admiralty Charts, in that of Abich (copied in Woodcut, Fig. 2), that of Sir W. Hamilton, of myself, and in every other published drawing of the island, as well as by several taken by my friend Mr. J. W. Judd, F.G.S., in the spring of this year, to be in proportion of about 3 to 2.

Indeed it is difficult to understand how Mr. Mallet himself can have seen the island from the sea at any distance on the north side, without perceiving this.

These gross errors of height-measurements make the following passage from Mr. Mallet's paper more remarkable (p. 502):

"The statements which have been" (hitherto) "made as to the relative heights of the different points of the island appear to be only derived from guess, and are greatly in error."

I might add, that Mr. Mallet seems incapable even of reading correctly the measurements given by others; since he expressly says in reference to the depth of water immediately beneath the crater-slope (p. 509):

"The Admiralty Charts indicate that for some miles in the offing here, the Mediterranean does not exceed 100 fathoms in depth."

I have, however, the Admiralty Chart before me, which gives soundings at more than one point within half a mile of the base of the crater-slope of 258 fathoms; which the French Admiralty Charts confirm, giving 480 mètres, at a little distance from the same base.

Mr. Mallet visited Stromboli in 1864. He was unfortunate, it seems, in the state of the atmosphere on the occasion of his visit, and was consequently unable to see to the bottom of the crater, through the clouds of vapour that filled it. He witnessed, however, as every other visitor had done, a series of intermittent explosions, throwing up red-hot scoriæ, bombs, and fragments of lava, together with steam, from what was evidently the crater of a volcano. And now, after ten years of mature deliberation, he has brought forward a theory to account for these explosions, which has at least the merit of novelty. He seems, indeed, to have formed his opinion, without the slightest reference to the *modus operandi* of other active volcanos, and without inquiring whether in any, or if so, in what respects the *phenomena of Stromboli* differ from those of an ordinary volcanic vent.

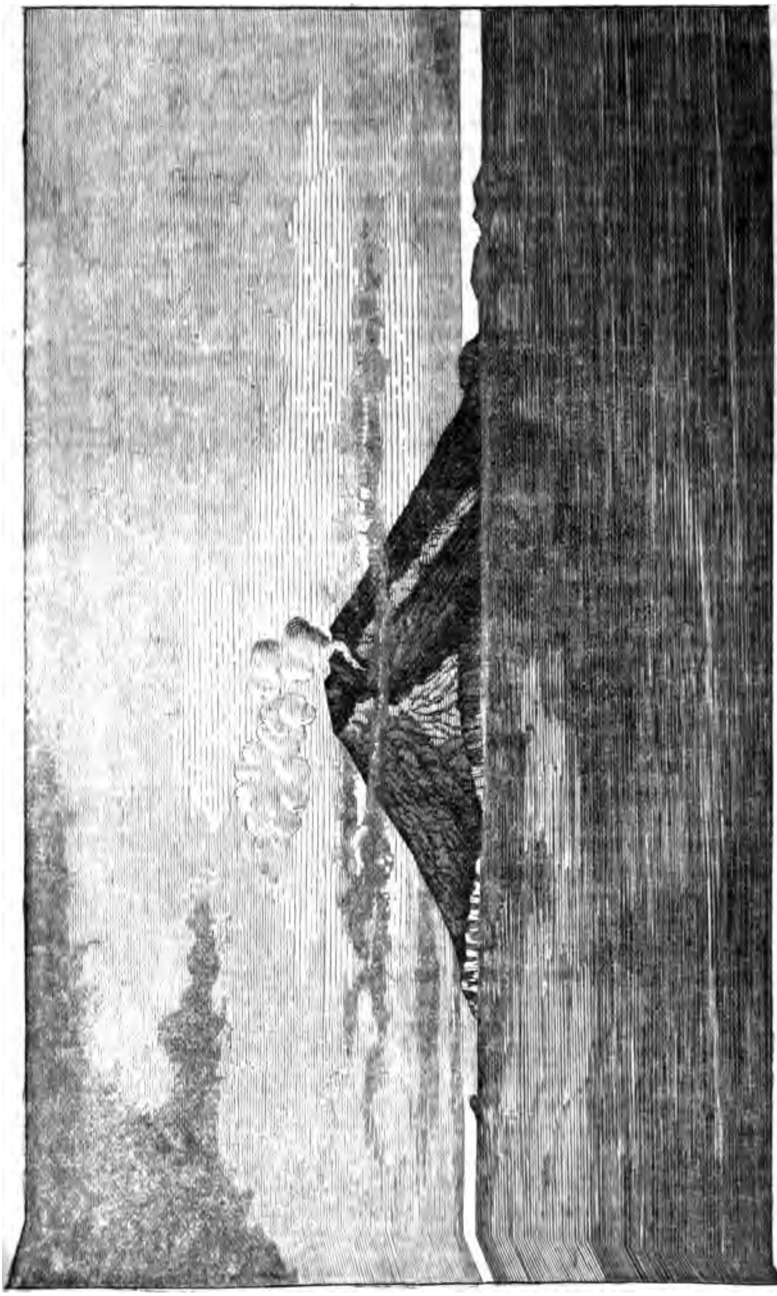


FIG. 2.—STROMBOLI VIEWED FROM THE NORTH (*after Abich*).

In reality, there is positively nothing in the recurrent explosions of Stromboli essentially different (as I shall presently show by ample testimony) from the similarly recurrent outbursts of any ordinary volcano during prolonged eruptions of moderate violence. There is, therefore, no call for any extraordinary explanation of these "rhythmical" outbursts in this particular case. And if Mr. Mallet, instead of setting his imagination to work upon the possible cause of their more or less regular occurrence, had adopted the humbler but more legitimate course of inquiring whether Stromboli stands alone in this respect, or whether other volcanos do not exhibit at times phenomena exactly similar—though rarely continuing for so long a time—he might have seen it to be quite unnecessary to invent a peculiar "mechanism" for Stromboli, unless, indeed, he means to apply it to all other volcanos likewise, which he has not gone the length of doing yet.

Mr. Mallet's theory is, that this celebrated island, which has hitherto been considered by all geologists as a typical volcano, is no volcano at all—at least, not of the usual igneous type—but a geyser, or intermittent fountain of boiling water, which, by some extraordinary chance, is situated at the bottom of a crater immediately beneath the mass of white-hot and liquid lava, which here, as in other volcanic craters when in activity, occupies that position, and is consequently tossed up into the air, in the shape of scoriæ, etc., at each outburst of the water. The tube of the supposed geyser is represented as occupying the place of the axial chimney of the volcano, and as alternately filled and emptied by the rise and escape from its mouth of a jet of boiling water and steam derived from some ducts or channels beneath the sea-level. The lava, which even Mr. Mallet cannot dispense with, since its projection into the air is the most obvious of all the phenomena, is supposed by him to flow to the mouth of the tube through lateral ducts from some undefined quarter, and the steam to be derived from a third kind of duct at a still greater depth below the sea than that which produces the water (page 512, Diag. 4). I submit that such a fortuitous concurrence of water, steam, and lava, proceeding from different sources or ducts, is a complicated and wholly imaginary supposition, without example, and unsupported by any facts or reasoning of the slightest value. Such an hypothesis could hardly have been expected of Mr. Mallet, who, in page 500 of his paper, justly says, "It may be taken as certain that in explaining all natural phenomena, the simplest explanation is the true one."

The simplest explanation of the phenomena of Stromboli would be to refer them to the ordinary mode of action of other volcanos. And certainly Mr. Mallet does not give any adequate, or even plausible, grounds for ascribing them to any different and extraordinary "mechanism." Mr. Mallet, I may remark, does not venture to say that he saw any column of water, like that of a geyser, thrown up from the crater's bottom, nor that any one else had ever witnessed such a sight. He admits that he could not see the bottom of the crater, owing to the clouds of vapour that obscured it, nor could he form a guess as to its depth, nor as to what was going on there, except *from the detonations* he heard, and the jets of red-hot stones, accompanied with steam, which pierced these clouds at each outburst. But other observers, especially Spallanzani in 1788, Hoffmann in 1831, and myself in 1819, were more fortunate, and saw at the bottom of the crater nothing in any respects resembling a geyser, but an orifice some seven or eight yards wide, full to the brim of seething white-hot lava, which swelled up from time to time in a dome-like form, and then fell again by some few feet below the mouth of the orifice, after giving issue to a burst of vapour mingled with scoriæ. That in its normal condition the throat of the volcano is so filled with fluid lava almost to the brim, is conclusively proved by the strong light reflected from the vapour-cloud above at every outburst of the red-hot scoriæ, which is seen nightly in the offing, and renders Stromboli a valuable lighthouse to mariners. This is, in fact, the ordinary condition of every volcano when in eruption. Such, for example, were the phenomena presented by the crater of Vesuvius on several occasions, as described by Deville, Roth, Abich, and other trustworthy observers.

The utter improbability of a geyser occupying the axial chimney of a volcano in more or less active igneous eruption, never seems to have occurred to Mr. Mallet's mind. Is it then a geyser that from the beginning has thrown up the volcanic agglomerates and lavas of which the island is wholly composed? Was it the geyser that blew away one large segment of the mountain, and formed the great breached crater? Or does the existence of the geyser only date from that paroxysmal eruption, when the present phase of moderate or sluggish eruptive activity probably began? Geysers occur in considerable numbers in Iceland, New Zealand, and other volcanic districts. But who ever saw one in the crater of a volcano, or throwing up red-hot lava? The geysers of Iceland are found in numbers close together upon a slightly raised platform in a valley —evidently the surface of a deep bed of lava which has flowed from Hecla, or some neighbouring volcano—the internal heat of which lava is still sufficient to produce the phenomena. The Great Geyser is about 70 feet deep. But if we correct Mr. Mallet's measurements of heights to make them agree with the truth, we shall find the depth of his imagined geyser tube from its mouth at the bottom of the crater to the sea, to be not 300 feet, as he represents it, but near 2,000. And this prodigious tube we are called on to believe is filled with hot water, and emptied again to the bottom at every explosion (p. 511). But, again, what is to prevent the heavy liquid lava, together with the fragmentary matter that falls or rolls to the bottom of the crater after each outburst, from entering the open mouth of the water-tube the moment it has been emptied of everything but air or vapour at the atmospheric pressure (which is Mr. Mallet's assertion), and filling it up so as to put an end to his geyser? Mr. Mallet tries to meet this obvious objection, by suggesting a *jam* of the coarser fragments cemented by lava and acting as a stopper. But is it conceivable that such an accidental jam should have occurred not once or twice only, but about ten times in every hour for the last 2,000 years or so? It is scarcely worth while, after these conclusive objections, to remark, that no siliceous sinter is found on the walls of the crater of Stromboli, such as geysers all over the world plentifully deposit, wherever their waters splash. On the other hand, the gases evolved from the crater, and the products of their action on its rocks, have been shown by the chemical analyses of Abich, Deville, and Fouqué, and the spectroscopic observations of Jansenn, to agree with those of ordinary volcanos.

As already mentioned, Mr. Mallet was not able to see to the bottom of the crater, owing to the vapour, which, he says, "nearly filled the cavity and obscured the bottom, even between the outbursts." Nevertheless, he guesses it to be 300 feet in depth below the rim (D in his Diagram). On what grounds he makes this guess he does not state. There is good reason to believe that the floor of the crater is but little below the lip D. Signor Salino estimated it (of course it is unapproachable) at 2,215 feet above the sea. The deep funnel-shaped cavity represented in Mr. Mallet's diagram may then be considered as wholly imaginary. My own estimate of 2,000 feet is declared by Mr. Mallet (p. 504), to involve "a physical impossibility;" his argument being founded on his own measurements of relative heights, which I have shown to be wholly erroneous. But then Mr. Mallet is in the habit of denouncing as "physical impossibilities," all alleged facts that do not square with his theories.

Mr. Mallet is evidently under the impression that the intermittent explosions of Stromboli, which he calls rhythmical, but which, as he himself admits, occur at very irregular intervals, are of an extraordinary and elsewhere unexampled character. But so far is this from the case that it forms the usual feature in every volcanic eruption of moderate violence. And of this Mr. Mallet would be aware if he had ever seen any other volcano than Stromboli in this phase. For example, M. Charles Ste.-Claire Deville thus summarizes his observations of Vesuvius in 1856, "Voila *le Vésuve actuellement dans la phase strombolienne.*" Monticelli thus describes the phenomena of Vesuvius in 1815: "The crater was often quiet *for minutes together*, and then burst out into explosions of considerable violence, sending fluid lava and ignited stones and ashes to a height of several hundred feet into the air." So, too, Sir H. Davy, describing the phenomena of December, 1819, says, "It threw up showers of red-hot stones every two or three minutes." (Phil. Trans. 1828.) I may add that, through several successive months in the years 1817–21, I myself watched nightly from Naples streams of lava which constantly overflowed the summit crater-lip of Vesuvius, and dribbled down the side of the cone, proving that the lava throughout that long time entirely filled the vent of the volcano; while from it successive explosions of steam, throwing up scoriæ, precisely like those of Stromboli, only somewhat more frequent, were continually taking place. Both phenomena—the overflow of lava and the outbursts of steam from it—went on without any apparent interference with each other; though it seemed evident that the continuous *rise* and expansion of successive steam bubbles from *within the vent* was one of the causes of the extrusion of the lava from the same orifice.[1]

The sluggish character of the eruptive action of Stromboli, as of other volcanos in a similar phase, is owing no doubt to the slow and equable rise of intensely heated lava within the vent; so slow as to admit of but one steam-bubble at a time being generated and pushed up; the lava about it losing much heat carried off in a latent form by the steam-bubble as it explodes, and requiring a further addition of heat to bring about, after an interval of more or less duration, the expansion of another steam bubble. During this interval, the surface of the lava remaining in the vent freezes, and by increasing the resistance to the expansive force below, further checks the development of the following steam-bubble. In cases where the increments of lava are forced up more rapidly, the formation of bubbles within the vent is proportionately accelerated, as well as their rise and escape from the mouth, till perhaps the explosions become so rapid and continuous as not to be easily counted. This is the case in every *violent* eruption; the puffs of steam from the vent being as rapid and the intervals between them as short as the very similar puffs from the chimney of a locomotive engine in full work. The first phase, that of sluggish activity, in a volcano, may be compared to the slow ebullition of a kettle on a hob; the phase of greater violence to one boiling over upon a brisk fire.

The volumes of steam which are seen to burst from the exposed lava surface of a volcanic vent in eruption, whether singly and at intervals, or in rapid succession and with tumultuous violence, are generated in the lava itself, and not in any imaginary fountain or pipe of hot water beneath it. The existence of interstitial water, either in a liquid, or a gaseous form in lava, both as it rises in and issues from a volcanic vent, has so long been recognized among geologists as an established fact, that it seems like going back to the scepticism of the Wernerian age to find a different motive force and mode of action brought forward to account for the phenomena of a volcano.

Had Mr. Mallet contented himself with the view expressed by Sir C. Lyell in a passage which I am inclined to believe suggested his theory,—since he refers to the context ('Principles,' 10th edition, vol. ii. p. 220), namely, that the phenomena of geysers "have no small interest as bearing on the probable mechanism of ordinary volcanic eruptions, namely, that the tube itself is the main seat or focus of mechanical force,"—he would have committed no error. But that would have been no novel idea, and he would not have written his paper and astonished the Royal Society with the assertion that the mechanism of Stromboli has not merely some similarity with that of a geyser, but that the volcano actually contains a geyser in its inside, which is the true and only source of the phenomena exhibited there.

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[1] I learn from Prof. Owen that on the night of the 3rd October, 1845, he watched the explosions of Vesuvius from the deck of a vessel in the Bay of Naples; and *timing* them by his watch, he found the intervals to vary between the *maximum* of minutes and the *minimum* 2 to 2½ seconds; from 3 to 4 minutes was about the rage time between the explosions.

The mechanism by which the rise of lava and steam within the vent is effected was explained by myself so early as 1825, in the first edition of my work on Volcanos (pp. 17–20), and more fully still in the edition of 1862 (pp. 39–43). It corresponds precisely with the view taken by Lyell in the "Principles" (tenth edition, vol. ii. p. 225), and also with that given by Dana (Manual, 1863, p. 692) in the following passage, which I quote in preference to my own, as the view of an impartial and unquestionable authority:

"*Volcanic Phenomena.*—The water and other vaporizable substances within the lava" (in the chimney of a volcano) "are under a pressure of about 125 pounds to the square inch for every 100 feet of depth. Owing to the heat, and their consequent expansion, they slowly rise in the heavy viscid liquid. As they rise, they keep expanding, until, nearing the surface, they begin to take the form of bubbles of vapour, and finally break through. . . If the lavas are less liquid, the vapours are kept from escaping by the resistance, until they have collected in far larger bubbles; and when such bubbles burst, the projectile force may be enormous; it carries the fragments far aloft, whence they descend in a shower of cinders of great extent. . . Such bubbles, rising and bursting, were seen by Spallanzani in the crater of Stromboli. In times of moderate action at Vesuvius, the outbursts of cinders occur every three to ten minutes; but in a period of eruption, they are almost incessant. . . As the vaporizable substances (water, sulphur, etc.) and atmospheric air expand while rising in the volcanic vent, they displace correspondingly the lava, and so cause a general expansion of the mass. This alone produces a rise of the lavas in the conduit."

It is then certain that, according to all trustworthy authorities, the outbursts of steam and other vapours, which during volcanic eruptions rise with and carry up to great heights in the air lava drops and fragments of rock, are seen in all cases to proceed from the lava itself, and not from any separate source of hot water, such as Mr. Mallet's ingenuity has invented. This has been recognized by every observer, who has had the good fortune to witness a volcanic vent in eruption from a commanding post, from the time of Spallanzani and Dolomieu to the present day.

Mr. Mallet, however, entertains very different ideas upon this subject. It seems that he is unwilling to admit that the water which, as steam, plays so important a part in volcanic eruptions, is contained within the lava as it rises in the vent from the interior of the volcano, and forces its way out explosively from the exposed surface on reaching the open air. Hence his determination to find or suggest some other sources of water and steam outside of the lava. Hence, too, he is unable to conceive the possibility of successive volumes of vapour struggling upwards within a narrow and intricate volcanic chimney, filled with more or less viscid lava, and successively bursting from its upper surface as they reach the atmosphere in the manner described by Dana in the above-quoted passage. Mr. Mallet asserts (R.S. Proceedings, p. 510): "Whatever be the source of supply of the lava, it can never fill the tube as a solid (sic) column of melted matter reaching up to its lip; for in that case, whatever be the mechanism of the volcano, at each outburst the whole of this immense column of melted matter must be blown completely out of the tube, which actually is emptied, at the end of each outburst, of everything but gases and vapours, and these at a tension not greatly exceeding that of the atmosphere." May we not, however, ask Mr. Mallet on what ground he asserts so positively, that the tube (which, in the case of Stromboli, he speaks of as 400 feet in depth, but which, by rectification of his measurements, must really be, if it exists at all there, about five times as much, viz. from the bottom of the crater to the level of the sea, whence the water of his geyser is supposed by him to be supplied) "must be actually emptied at every outburst"? He admits that he was unable to see the bottom of the crater where he places the mouth of his geyser tube. Those who have been more fortunate certainly saw nothing corresponding to Mr. Mallet's idea, but, on the contrary, the usual phenomena of a volcanic vent in moderate activity, as described above. There is nothing, then, in the phenomena of Stromboli so exceptional as to make it necessary to refer them to any mechanism different from that of ordinary volcanos under similar conditions. Intermittent, recurrent, or (if Mr. Mallet prefers the word) *rhythmical* explosions are not peculiar to Stromboli. Dana, as we have seen, and other trustworthy authorities, speak of those of Vesuvius, when the volcano is but moderately active, as taking place every three or ten minutes,—as nearly as possible, the average interval between the outbursts of Stromboli,—though of course, in more violent paroxysmal eruptions, the intervals are reduced to seconds or less, the explosions following one another too rapidly to be counted.

It is, then, evident that if Stromboli is to be supposed to have a geyser under its eruptive lava-vent, on account of the intermittence of its explosions, we must believe the same to be the fact in the case of Vesuvius, and every other volcano when in activity—an absurdity which no geologist can be brought to countenance, and which even Mr. Mallet would (perhaps?) hesitate to affirm.

The peculiarity of Stromboli really consists, not in the more or less rhythmical recurrence of its explosions,—which, as we have seen, is common to all volcanos in the phase of moderate eruptive activity,—but in the permanence of this phase in its instance. This is evidently due to the slow and equable rate at which increments of heat are communicated from beneath, together with fresh lava rising up the chimney, and to the similarly equable dispersion of the matter thus brought up, beyond the circumference of the crater. This equilibrium of supply and waste is an unquestionable fact, since the eruptive phenomena are, as a rule, equable within short periods, and the crater remains always empty to about the same level, notwithstanding the constant return into it of a large proportion of the lava fragments ejected from its bottom. That other portion of fragmentary lava which is carried off as ash by the wind, or falls in larger masses outside the crater lip, evidently balances in general the amount supplied from beneath. Were it not so, the accumulation of matter in and above the crater would probably so far increase the pressure on the steam in the chimney of the volcano as to proportionately check its expansive force, and cause the eruptions to cease for a time far longer than the present intervals, and to be more violent when they did occur, and thus bring the volcano into the more common phase of alternate great activity and prolonged repose. The maintenance of this equilibrium between the expansive and repressive forces is probably due (as I long since suggested) to the peculiar shape of this volcanic mountain (see Woodcut Fig. 3); its axial vent being so close to the ridge of the steeply inclined plane that occupies the breached crater and reaches down to and far below the sea-level, as to admit of a considerable portion of the ejected fragments falling into deep water, instead of accumulating over the vent, as would be the case if the circuit of the crater was complete on that side. Any excess of lava produced by the vent in a liquid form escapes in like manner, either through or over this crater-lip, to the exterior of the slope, and thence into the sea. In this explanation Hoffmann expresses his concurrence. In 1831, this observer saw several minor streams of lava issuing from the summit of the slope, and making their way down towards the sea; and the same fact has been noticed by others. The great depth of the Mediterranean at the base of this slope, assisted by currents, would prevent the accumulation of the ejected matters on that side.

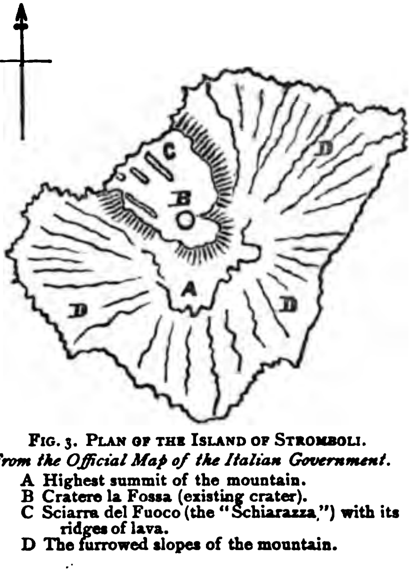

FIG. 3. PLAN OF THE ISLAND OF STROMBOLI.
From the Official Map of the Italian Government.

A Highest summit of the mountain.
B Cratere la Fossa (existing crater).
C Sciarra del Fuoco (the "Schiarazza,") with its ridges of lava.
D The furrowed slopes of the mountain.

It is evident, on the whole, that Mr. Mallet's theory cannot stand serious examination. Stromboli is only one of a string of volcanic islands (the Liparis), arranged along radiating lines evidently marking some subterranean fissures, which have all apparently been in eruption within Post-Tertiary times. One of them, indeed (Vulcano), has been several times violently eruptive within the historical period, and is even now in the Solfatara state of activity, sending forth volumes of acid vapours and steam. Last autumn, indeed, a veritable eruption on a small scale broke out at the bottom of its immense crater, luckily not at the point where the sulphur and borax works, established by an enterprising Scotch firm, are situated. It would need, therefore, a very strong proof to lead geologists to believe that the action of Stromboli is essentially different in its character *and cause from* that of the other ordinary volcanic vents of the *series, and such* Mr. Mallet, as has been seen, fails entirely to produce.

Although I have hitherto spoken of the explosions of Stromboli as equable, yet they do not by any means occur at precisely similar intervals. These, though usually of from two to ten minutes, are sometimes prolonged to thirty or even forty minutes. Nor is the violence of the discharges always equal. According to information furnished by the inhabitants of the island, the explosions are of a more violent character in stormy weather, especially in winter; and there is a tradition, as old at least as Pliny, that they forecast the weather for some days to come by the condition of the smoke, i.e. the steam-cloud evolved from the mountain. I long since (Volcanos, ed. 1825, pp. 53–4) suggested that changes in the pressure of the atmosphere on the elastic vapours, enclosed in the lava within and below the volcano, might produce this effect. Mr. Mallet declares this to be "impossible." But I am not inclined to renounce the idea in deference to his arguments. Bearing in mind the well-known fact—which appears to afford a strong parallel to the case in point—that a fall in the barometer is accompanied by the letting loose of the elastic vapours confined in the vacant spaces of a coal-mine with such violence as at times to force down masses of rock from the roof of the workings, it seems not impossible that within or below the chimney of a volcano communicating with the open air, similar effects may be produced by the same cause.[1]

However this may be, the fact remains that the volcano is at some times and seasons more turbulent than at others. The inhabitants assert that in its eruptions of greatest violence lava is occasionally discharged into the sea from the steep face of the great rent on the north-west side, which bears the local name of the Schiarazza ("the great scar"). Hoffmann, as we have seen, confirms this fact; and Sir W. Hamilton gives a coloured drawing of the island, taken by his friend in the year 1768 (see Campi Phlegræi, plate xxxvii.), when a violent eruption was taking place, apparently from the whole upper portion of the Schiarazza. Mr. Mallet, indeed, doubts that lava can ever, in recent times, have been emitted by Stromboli, on the ground that the crater must have been first filled to the brim, to enable the lava to overflow it. There is reason to doubt the bottom of the crater being much lower than the lowest part of its brim. Even were this the case, it would be quite possible and consistent with facts which I am about to notice, that lava may have flowed into the sea from fissures broken through the bank which separates the Schiarazza from the lowest hollow of the crater. Mr. Mallet, indeed, himself noticed strings of lava which looked like dykes, in the face of the great rent, but is unwilling to admit that they are such, considering them merely long flakes or ropy portions of lava that had fallen from above. The fact I have to mention in support of the contrary view is the remarkable one mentioned by Spallanzani, Hoffmann, myself, and others, that besides the opening at the bottom of the crater which is filled to the brim with boiling lava, and whence the explosive discharges of scoriæ, etc., take place, there is, or was at the several times of our visits, at least one other orifice, empty to all appearance, but from which steam, seemingly dry, is constantly rushing up with a dull roar and frequent stifled detonations. This steam must proceed from lava at a lower level than that of the proximate vent only a few yards off, with which it is evidently not in communication for some distance down. It is therefore easy to believe that other openings may give issue to lava at a still higher level on the outer flank of the Schiarazza, without the crater being necessarily filled at the same time. Similar facts have been often recorded. For example, M. Deville saw on the summit of Vesuvius, in 1856, two contiguous small craters, within one of which a pool of incandescent lava continually bubbled up, while the bottom of the other, at a lower level by at least 300 feet, was empty; showing, as he justly observes, the extreme localization of the ascending lava in separate, though closely adjoining, fissures or chimneys. The parallel between the two cases is complete. Several of the distinguished observers already mentioned have described within the crater of Stromboli a number of additional mouths, sometimes amounting to seven, and discharging either steam, stones, or lava streams, and acting singly or in concert. In short, it appears probable that the bottom of the crater of Stromboli, like that of many other volcanos, is a mere crust of scoriform lava liable to variations both in its level and in the number and character of its openings.

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[1] The attitude of philosophical caution which should be maintained by us with regard to such questions was admirably pointed out by the late lamented Professor Phillips in the following passage:—"It is a common belief among persons who do not require strict proof of propositions which they accept, that the weather has influence on such phenomena as earthquakes and volcanos; the same minds may readily admit the influence of the moon on the weather; and thus we arrive easily at the opinion that Vesuvius is governed in its activity by the phases of the moon. On the other hand, men trained in exact reasoning are apt to deride such notions as quite unworthy of inquiry. Neither of these conditions of mind is right, when the problem is one like that of volcanos, for which a just solution cannot be had without taking into careful estimation all the known forces which may be influential on the epoch, duration, and intensity of the effect."—*Vesuvius*, page 169.

Enough has been said to show that there is no ground whatever for attributing to Stromboli any mechanism different from that of ordinary volcanos. Its activity is sluggish, and has continued for a very long period. But this is a phase by no means unexampled. The volcano of Masaya, in the State of Nicaragua, has been in a similar condition of moderate eruptive activity since the year 1529 at least, (see Volcanos, 1862, p. 33), discharging at intervals of fifteen minutes jets of red-hot lava fragments from its crater. Mr. Squiers, in his recent work on Nicaragua, confirmed this fact. Again, on the Pacific coast of Central America, in the province of Guatemala, another volcano, Isalco, has been in a condition of permanent activity since 1770, in which year a cone was first thrown up on a plain, and has been growing in size ever since. Mr. Squiers represents it as being 2,500 feet high at the time of his visit, and its explosions as regularly recurring at intervals of twenty minutes. This statement is borne out by the diary of my friend Mr. Chas. Eden, written on board the U.S. Packet "Guatemala," in the *gulf of Fonseca, in the* year 1859, which I have now before me. He states that "eruptions take place from this volcano at intervals of from 10 to 12 minutes; it forms therefore a beautiful beacon by night; its intermittent fires seem like some colossal revolving light." Another permanently active volcano is said to exist in the Kamtschatkan group, and others would appear to occur in the New Hebrides and several of the Pacific Islands.

Mr. Mallet's suggestion, therefore, in the case of Stromboli, of a geyser beneath an active volcanic vent, may be dismissed as wholly unnecessary, as well as improbable, not to say impossible. The promulgation, however, of this strange notion, together with the arguments adduced to support it, may perhaps serve to show that I was justified, when commenting on Mr. Mallet's "theory of Vulcanicity," in saying that he appeared to have no very clear or just notions upon the character of volcanic action, and may therefore excuse the seeming discourtesy of the remark. When a physicist of some reputation—and I am far from denying Mr. Mallet's claim to that title in his own sphere—produces a novel theory of great pretensions, which is, by his own showing, to upset the views previously held by all geologists on the subject, while expressing no small contempt for their opinions and arguments, he must expect his own views, when he deals with geological facts, to be closely scrutinized and estimated at their true worth.

II.—List of Palæozoic Fishes.

By W. J. Barkas, L.R.C.P. Lond., M.R.C.S. Eng.

(Edited and Revised by William Davies, of the British Museum.)

PALÆONTOLOGY, like most other sciences, has attracted a large number of students since the first pioneers cleared the way for inquiry and brought the fossil remains into something like connected order. This increase in the number of inquirers has borne fruit in the immense variety of fossil remains that are scattered about in museums and private collections, the variety being now so great that it has become almost impossible for one person to study the whole of them, in consequence of which the majority of students confine themselves to the fossils of one formation or to the remains of a natural order, as Invertebrata or Vertebrata. Here, again, the application of a number of investigators to one distinct branch is bringing a further increase to our knowledge in that branch. Take the case of fossil fishes. It was quite possible twenty or thirty years ago for the great palæontologist Agassiz to describe and figure what, as the result of seventeen years of close study, was then known of the fossil fishes of all formations; but the stimulus that resulted from the publication of his work has piled up the list in a wonderful manner, so that it would be well-nigh impossible for any ordinary palæontologist to describe them all now in anything like a satisfactory way. This great amplification necessitates inquirers to confine themselves to the fish remains of a single formation, or to a particular part of the fish, as for example, the teeth. One result of this disjointed manner of collecting is that a number of fish remains e discovered, most of which are allowed to lie undescribed in ivate collections, and those that are named and recorded are equently similar to others (but named differently) in the cabinets persons in other localities in widely different parts of the orld.

It has occurred to me that a list of all the Palæozoic fishes that ve been described up to this period would be of great utility to læontologists, and would enable any future discoverer to learn at glance what species had already been found belonging to the genus his supposed new fish, and before he gave it a specific name it ould be desirable that he should carefully compare it with all the her species of that genus. Another advantage accruing from ch a list is that one would be enabled to see immediately what shes are considered Palæozoic at the present stage of palæonto-gical research. If similar lists of Mesozoic and Cainozoic fishes ere published in the GEOLOGICAL MAGAZINE, the benefit would be ill greater, for they would show what genera of fishes passed from e period to another. These are one or two of the reasons for y compiling this list; but the chief object is that I desire to study e *teeth* of all Palæozoic fishes that are known to have teeth, and it necessary beforehand to ascertain what genera and species have en discovered. Of course it is impossible to obtain the teeth of all e fishes named below, for many are known to be edentate, others e founded upon spines alone, some on scales, shagreen, or other rts of a fish, the teeth of which have not been discovered, or if dis-vered, have not been correlated with the parts enumerated.

It is not improbable that the list I now give is imperfect, for I may ve overlooked some species or even genera contained in works that e to me inaccessible, and there can be no doubt that in some cases e same fish figures under two or more names. I have been as reful as possible not to fall into this error; but the literature of ssil fishes is so exceedingly scattered and scanty, that it is almost npossible to learn from that source what are their characters. As a rther precaution, Mr. William Davies, of the Geological Department the British Museum, has kindly corrected and revised the list, us rendering it of far greater value to the scientific student fossil Ichthyology. In this state it is placed before the aders of the GEOLOGICAL MAGAZINE, and there can be no doubt, fter the careful revision it has received at the hands of Mr. Davies, at it is the most complete list of Palæozoic fossils that has as yet een published; and I trust that it will not be long before similar omplete lists are issued of the fishes of the more recent eras. When, examining the various works for the purposes of this list, I have ound two names, one of which was considered to be a synonym the other, I have struck one of them out of its supposed genus and laced it as a synonym of the other. For example, *Cochliodus striatus* a synonym of *Xystrodus striatus*. *C. striatus* was first named by gassiz, but a subsequent investigation appears to have led him to onsider that it was not a good species; he, therefore, divided it to two *species having* the generic name Xystrodus. Should any omissions have occurred, or any fish given below be known to be a synonym of another, and not a good species, I shall be glad if such errors are made known to me; and if necessary, I shall prepare a supplementary list. All the synonyms in the following list are set further in, and are printed in smaller type immediately below the true name; the generic names are printed in capital letters of two sizes, the larger capitals denote the true genus, while the smaller capitals distinguish the synonyms; all the species are printed in italics.

The following abbreviations have been introduced:—

S. Silurian; D. Devonian; C. Carboniferous; P. Permian.

Ag. Agassiz; Asm. Asmuss; Beyr. Beyrich; v. Bened, van Beneden; Blain. Blainville; Buck. Buckland; Eg. Egerton; Eich. Eichwald; Ethr. Etheridge; Fisch. Fischer; Germ. Germar; Gieb. Giebel; Gold. Goldfuss; H. & A. Hancock and Atthey; H. & S. Huxley and Salter; Hux. Huxley; Keys. Keyserling; Kon. de Koninck; Lank. Lankester; Mnstr. Münster; Murch. Murchison; Newb. Newberry; N. & W. Newberry and Worthen; Pand. Pander; Redf. Redfield; Roem. Roemer; Sedg. Sedgwick; S. & M. Sedgwick and Murchison; Traq. Traquair.

CONODONTS.

ACODUS *acutus*, Pand.	S
crassus, Pand.	,,
erectus, Pand.	,,
planus, Pand.	,,
sigmoideus, Pand.	,,
ACONTIODUS *gracilis*, Pand.	,,
latus, Pand.	,,
triangularis, Pand.	,,
BELODUS *gracilis*, Pand.	,,
CENTRODUS *convexus*, Pand.	,,
duplicatus, Pand.	,,
lineatus, Pand.	,,
simplex, Pand.	,,
CORDYLODUS *angulatus*, Pand.	,,
rotundus, Pand.	,,
CTENOGNATHUS *Keyserlingii*, Pand.	,,
Murchisoni, Pand.	,,
obliquus, Pand.	,,
Verneuillei, Pand.	,,
DREPANODUS *acutus*, Pand.	,,
arcuatus, Pand.	,,
flexuosus, Pand.	,,
inflexus, Pand.	,,
obtusus, Pand.	,,
GNATHODUS *mosquensis*, Pand.	,,
MACHAIRODUS *angustus*, Pand.	,,
canaliculatus, Pand.	,,
dilatatus, Pand.	,,
ensiformis, Pand.	,,
inæqualis, Pand.	,,
incurvus, Pand.	,,
planus, Pand.	,,
primævis, Leidy	,,
rhomboideus, Pand.	,,
solidus, Pand.	,,
OISTODUS *acuminatus*, Pand.	,,
inæqualis, Pand.	,,
lanceolatus, Pand.	,,
parallelus, Pand.	,,
PALTODUS *bicostatus*, Pand.	S
canaliculatus, Pand.	,,
obtusus, Pand.	,,
rotundatus, Pand.	,,
subæqualis, Pand.	,,
truncatus, Pand.	,,
PRIONODUS *carinatus*, Pand.	,,
elegans, Pand.	,,
sulcatus, Pand.	,,
Tulensis, Pand.	,,
Volborthii, Pand.	,,
PRIONOGNATHUS *Brandtii*, Pand	,,
SCOLOPODUS *æquilateralis*, Pand.	,,
costatus, Pand.	,,
quadratus, Pand.	,,
semicostatus, Pand.	,,
striatus, Pand.	,,
sublævis, Pand.	,,

SELACHIANS.

ACRODUS *Flemingianus*, Kon.	C
lateralis, Ag.	,,
ANTHROPODONTOIDES *Bailesii*, Barkas	,,
ANTLIODUS *cucullus*, N. & W.	,,
micronatus, N. & W.	,,
minutus, N. & W.	,,
parvulus, N. & W.	,,
politus, N. & W.	,,
robustus, N. & W.	,,
sarcululus, N. & W.	,,
similis, N. & W.	,,
simplex, N. & W.	,,
sulcatus, N. & W.	,,
ASPIDODUS *convolutus*, N. & W.	,,
crenulatus, N. & W.	,,
ASTEROPTYCHIUS *ornatus*, Ag.	,,
Portlocki, Ag.	,,
semiornatus, M‘Coy	,,

Asteroptychius *triangularis*, [N. & W.	C
Aulacodus *obliquus*, Pand.	S
Byssacanthus *arcuatus*, Ag.	D
Onchus *arcuatus*, Ag.	,,
B. *crenulatus*, Ag.	,,
B. *dilatatus*, Eich.	,,
B. *lævis*, Ag.	,,
Onchus *dilatatus*, Eich.	,,
Campodus *Agassizianus*, Kon.	C
Carcharopsis *Portlocki*, Ag.	,,
prototypus, Ag.	,,
semiornatus, M'Coy.	,,
Wortheni, Newb.	,,
Characodus *angulatus*, Ag.	,,
Psammodus *cornutus*, Ag.	,,
C. *cuneatus*, Ag.	,,
Psammodus *cornutus*, Ag.	,,
Cheirodus *lateralis*, Eich.	D
Ceratodus *lateralis*, Eich	,,
Cheirodus, *Jerofejewi*, Pand.	,,
C. *pes-ranæ*, M'Coy	C
Chilodus *gracilis*, Gieb.	,,
tuberosus, Gieb.	,,
Chomatodus *affinis*, N. & W.	,,
angularis, N. & W.	,,
arcuatus, St. John	,,
cinctus, Ag.	,,
Helodus *cinctus*, M'Coy	,,
Psammodus *cinctus*, Ag.	,,
C. *clavatus*, M'Coy	,,
costatus, N. & W.	,,
cultellus, N & W.	,,
denticulatus, M'Coy	,,
Helodus *denticulatus*, M'Coy	,,
C. *elegans*, N. & W.	,,
gracillimus, N. & W.	,,
linearis, Ag.	,,
Psammodus *linearis*, Ag.	,,
Helodus *linearis*, M'Coy	,,
C. *loriformis*, N. & W.	,,
molaris, N. & W.	,,
multiplicatus, N. & W.	,,
obliquus, M'Coy.	,,
Helodus *obliquus*, M'Coy	,,
C. *pusillus*, N. & W	,,
truncatus, Ag.	,,
Petalodus *truncatus*, M'Coy	,,
C. *venustus*, Leidy	,,
Cladacanthus *paradoxus*, Ag.	,,
Cladodus *acutus*, Ag.	,,
angulatus, N. & W.	,,
basalis, Ag.	,,
conicus, Ag.	,,
costatus, N. & W.	,,
deflexus, N. & W.	,,
elegans, N. & W.	,,
ferox, N. & W.	,,
gracilis, N. & W.	,,
grandis, N. & W.	,,
Hibberti, Ag.	,,
hybodoides, Barkas	,,
C. *mirabilis*, H. & A.	,,
C. *ischypus*, N. & W.	,,
lamnoides, N. & W.	,,
lævis, M'Coy	,,

Cladodus *magnificus*, N. & W.	C
marginatus, Ag.	,,
micropus, N. & W.	,,
Milleri, Ag.	,,
mirabilis, Ag.	,,
mortifer, N. & W.	,,
occidentalis, M. & H.	,,
parvus, Ag.	,,
politus, N. & W.	,,
robustus, N. & W.	,,
simplex, Ag.	D
Hybodus *longiconus*, Eich.	
C. *spinosus*, N. & W.	C
stenopus, N. & W.	,,
striatus, Ag.	,,
turritus, N. & W.	,,
zygopus, N. & W.	,,
Cochliodus *compactus*, Ow.	,,
contortus, Ag.	,,
Psammodus *contortus*, Ag.	,,
C. *costatus*, N. & W.	,,
crassus, N. & W.	,,
lævissimus, Newb.	,,
nobilis, N. & W	,,
Compsacanthus *lævis*, Newb.	,,
Copodus *cornutus*, Ag.	,,
Psammodus *cornutus*, Ag.	,,
C. *furcatus*, Ag.	,,
Psammodus *cornutus*, Ag.	,,
C. *lunulatus*, Ag.	,,
Psammodus *cornutus*, Ag.	,,
C. *spathulatus*, Ag.	,,
Psammodus *cornutus*, Ag.	,,
Coscinodus *Agassizii*, Pand.	S
Cosmacanthus *carbonarius*, [M'Coy	C
Malcolmsoni, Ag.	D
Cricacanthus *Jonesi*, Ag.	C
Ctenacanthus *abnormis*, Gieb.	S
angulatus, N. & W.	C
arcuatus, Ag.	,,
Bohemicus, Barr.	S
brevis, Ag.	C
Ichthyodorulithes *brevis*, Buckl.	
C. *costatus*, N. & W.	,,
crenulatus, Ag.	,,
denticulatus, M'Coy	,,
distans, M'Coy	,,
gracillimus, N. & W.	,,
heterogyrus, Ag.	,,
hybodoides, Eg.	,,
major, Ag.	,,
Mayi, N. & W.	,,
minor	,,
nodosus, Eg.	,,
tenuistriatus, Ag.	,,
Ctenopetalus *serratus*, Ag.	,,
Petalodus *serratus*, Ow.	,,
Ctenoptychius *serratus*, Ag.	,,
Ctenoptychius *aciculatus*, [Barkas	,,
cristatus, Dawson	,,
cuspidatus, Ag.	,,
denticulatus, Ag.	,,

CTENOPTYCHIUS *marginalis*, Ag. C
pectinatus, Ag. ,,
AGEOLODUS *diadema*, Owen ,,
C. *priscus*, Ag. D
radicans, Ag. C
unilateralis, Barkas ,,
CYMATODUS *oblongus*, N. & W. ,,
DACTYLODUS *digitatus*, N. & W. ,,
CTENOPTYCHIUS *digitatus*, Leidy ,,
C. *inflexus*, N. & W. ,,
lobatus, N. & W. ,,
princeps, N. & W. ,,
DELTODUS *alatus*, N. & W. ,,
angularis, N. & W. ,,
angustus, N. & W. ,,
cingulatus, N. & W. ,,
complanatus, N. & W. ,,
fasciatus, N. & W. ,,
grandis, N. & W. ,,
Littoni, N. & W. ,,
rhomboideus, N. & W. ,,
spatulatus, N. & W. ,,
stellatus, N. & W. ,,
sublævis, Ag. ,,
PÆCILODUS *sublævis*, Ag. ,,
parallelus, Ag. ,,
D. *undulatus*, N. & W. ,,
DELTOPTYCHIUS *acutus*, Ag. ,,
COCHLIODUS *acutus*, Ag. ,,
D. *gibberulus*, Ag. ,,
COCHLIODUS, Ag. ,,
DREPANACANTHUS *anceps*,
[N. & W. ,,
gemmatus, N. & W. ,,
stellatus, N. & W. ,,
DICRENODUS *Okensis*, Roem ,,
DIMERACANTHUS *concentricus*,
[Keys. D
DIMYLEUS *Woodi*, Ag. C
PSAMMODUS *cornutus*, Ag. ,,
DIPLODUS *acinaces*, Dawson ,,
compressus, Newb. ,,
duplicatus, N. & W. ,,
gibbosus, Ag. ,,
PLEURACANTHUS *gibbosus*, Eg. ,,
lævissimus, Ag. ,,
lævidens, Kner ,,
ptychodus, Kner ,,
AGANODUS *apicalis*, Owen ,,
undatus, Owen ,,
PTERNODUS *productus*, Owen ,,
OCHLODUS *crassus*, Owen ,,
D. *gracilis*, Newb. ,,
incurvus, N & W. ,,
latus, Newb. ,,
minutus, Ag. ,,
DITTODUS *divergens*, Owen ,,
D. *penetrans* ,,
DIPRIACANTHUS *falcatus*, M'Coy ,,
Stokesii, M'Coy ,,
EDESTES *Heinrichsii*, N. & W. ,,
minor, Newb. ,,
vorax, Leidy ,,
ERISMACANTHUS *Jonesii*, M'Coy ,,
GETALODUS (?) *Ohionensis*, Safford ,,
GLOSSODUS *marginatus*, M'Coy ,,

GYRACANTHUS *Alnwicensis*, Ag. C
ICHTHYODORULITHES *Alnwicensis*,
[Buck. ,,
G. *duplicatus*, Dawson ,,
formosus, Ag. ,,
magnificus, Dawson ,,
obliquus, M'Coy ,,
ornatus, Ag. ,,
tuberculatus, Ag. ,,
MITRODUS *quadricornis*, Owen, ,,
GYROPRISTIS *obliquus*, Ag. P
HAPLACANTHUS *tenuisulcatus*, Eich D
H. *marginalis*, Ag. ,,
HARPACODUS *dentatus*, Ag. C
CTENOPTYCHIUS *dentatus*, Ag. ,,
HELODUS *angulatus*, N. & W. ,,
antiquissimus, Eich. D
appendiculatus, M'Coy ,,
biformis, N. & W. ,,
carbonarius, N. & W. ,,
compressus, N. & W. ,,
coniculus, N. & W. ,,
consolidatus, N. & W. ,,
crenulatus, N. & W. ,,
denshumani, N. & W. ,,
denticulatus, N. & W. ,,
didymus, Ag. ,,
GLOSSODUS *lingua-bovis*, M'Coy ,,
H. *elytra*, N. & W. ,,
gibberulus, Ag. ,,
PSAMMODUS *gibberulus*, Ag. ,,
H. *gibbosus*, N. & W. ,,
lævissimus, Ag. ,,
PSAMMODUS, *lævissimus*, Ag. ,,
H. *limax*, N. & W. ,,
mammillaris, Ag. ,,
mitratus, Ag. ,,
nobilis, N. & W. ,,
obliquus, M'Coy ,,
placenta, N. & W. ,,
politus, N. & W. ,,
rudis, M'Coy ,,
rugosus, N. & W. ,,
simplex, Ag. ,,
subteres, Ag. ,,
PSAMMODUS *subteres*, Ag. ,,
H. *sulcatus*, N. & W. ,,
tuberculatus, Ag. ,,
turgidus, Ag. ,,
PSAMMODUS *turgidus*, Ag. ,,
H. *undulatus*, N. & W. ,,
HOLODUS *Kiprijanowi*, Pand. D
HOMACANTHUS *gibbosus*, N. & W. C
macrodus, M'Coy ,,
microdus, M'Coy ,,
rectus, N. & W. ,,
triangularis, Eich. D
HYBODOPSIS *Wardi*, sp. ined.,
[Barkas ,,
HYBODUS *carbonarius*, Gieb. ,,
Daviesii, sp. ined., Barkas ,,
n. sp., Barkas ,,
CLADODUS mirabilis, H. & A. ,,

HYBODUS *Panderi*, Eich.	D
H. *subcarinatus*	"
H. *vicinalis*, Gieb.	"
LABODUS *planus*, Ag.	"
PSAMMODUS *cornutus*, Ag.	"
L. *prototypus*, Ag.	"
PSAMMODUS *cornutus*, Ag.	"
LEPRACANTHUS *Colei*, Eg.	"
LEPTACANTHUS	"
Jenkinsoni, M'Coy	"
junceus, M'Coy	"
occidentalis, N. & W.	"
priscus, Ag.	"
remotus, Eich.	"
LISTRACANTHUS *hystrix*, N. & W.	"
LOPHODUS *variabilis*, N. & W.	"
MACHŒRACANTHUS *peracutus*, N.	"
sulcatus, Newb.	"
MESOGOMPHUS *lingua*, Ag.	C
PSAMMODUS *cornutus*, Ag.	"
MONOPLEURODUS *Ohhesaarensis*, [Pand.	S
MYLACODUS *quadratus*, Ag.	C
PSAMMODUS *cornutus*, Ag.	"
MYLAX *batoides*, Ag.	"
PSAMMODUS *cornutus*, Ag.	"
NAULAS *sulcatus*, Ag.	"
NEMACANTHUS *priscus*, M'Coy	"
ODONTACANTHUS *asterolepis*	D
NARCODES *pustulifer*, Ag.	"
LOPHOLEPIS *Schmidtii*, Pand.	S
O. *crenatus*, Ag.	D
CTENOPTYCHIUS *crenatus*, Ag.	
O. *heterodon*, Ag.	"
ONCHUS *curvatus*, Pand.	S
compressus, Eich.	P ?
Deweyi, Hall	"
dubius, Pand.	"
falcatus, Ag.	C
hamatus, Ag.	"
heterogyrus, Ag.	D
major, Ethr.	"
Murchisoni, Ag.	S
plicatus, Ag.	C
rectus, Ag.	"
semistriatus, Ag.	D
sublævis, Ag.	"
subulatus, Ag.	C
sulcatus, Ag.	"
ICHTHYODORULITHES *Bristoliensis*, [Buck.	
O. *tenuistriatus*, Ag.	D
tricarinatus, Pand.	S
ORACANTHUS *abbreviatus*, Newb.	D
confluens, Ag.	C
Milleri, Ag.	"
ICHTHYODORULITHES *curvicostatus*, [Buck.	
O. *minor*, Ag.	"
pnigeus, N. & W.	"
pustulosus, Ag.	"
vetustus, Leidy	"
ORODUS *angustus*, Ag.	"
catenatus, Ag.	"
cinctus, Ag.	"

ORODUS *compressus*, M'Coy	C
corrugatus, N. & W.	"
elegantulus, N. & W.	"
gibbus, Ag.	"
mammillaris, N. & W.	"
minusculus, N. & W.	"
minutus, N. & W.	"
multicarinatus, N. & W.	"
ornatus, N. & W.	"
plicatus, N. & W.	"
porosus, M'Coy	"
ramosus, Ag.	"
tuberculatus, N. & W.	"
ORTHACANTHUS *cylindricus*, Ag.	"
PALÆDAPHUS *Devoniensis*, v. Bened	D
insignis, v. Bened. & Kon.	"
PELTODUS *unguiformis*, N. & W.	"
PERIPRISTIS *semicircularis*, N. & W.	C
CTENOPTYCHIUS *semicircularis* [N. & W.	"
PETALODOPSIS *mirabilis*, Barkas	"
PETALODUS *Alleghaniensis*, Leidy	"
apicalis, Barkas	"
CTENOPTYCHIUS *apicalis*, Ag.	"
macrodus, Ag.	"
PETALODUS *dentatus*, Ow.	"
P. *curtus*, N. & W.	"
destructor, N. & W.	"
Hastingsiæ, Owen	"
P. *rhombus*, M'Coy.	"
acuminatus, Ag.	"
CHOMATODUS *acuminatus*, Ag.	"
P. *lævissimus*, Ag.	"
linguifer, N. & W.	"
marginalis, Ag.	"
parvulus, N. & W.	"
politus, N. & W.	"
sulcatus, N. & W.	"
n. sp. Barkas	"
PETALORHYNCHUS *psittacinus*, Ag.	"
PETALODUS *psittacinus*, Ag.	"
sagittatus, Ag.	"
P. *striatus*, N. & W.	"
PETRODUS *acutus*, N. & W.	"
occidentalis, N. & W.	"
patelliformis, M'Coy	"
pustulosus, N. & W.	"
PHYSONEMUS *arcuatus*, M'Coy	"
gigas, N. & W.	"
subteres, Ag.	"
PINACODUS *gelasimus*, Ag.	"
PSAMMODUS *cornutus*, Ag.	"
P. *gonoplax*, Ag.	"
PSAMMODUS *cornutus*, Ag.	"
P. *sesamini*, Ag.	"
PSAMMODUS *cornutus*, Ag.	"
PLATYCANTHUS *isosceles*, M'Coy	"
PLEURACANTHUS *cylindricus*, Ag.	"
Frossardi, Gaudry.	"
laciniatus, Roem.	D
minutus, Ag.	C
planus, Ag.	"
porosus, Eich.	D
tuberculatus, Eich.	"

PLEURODUS *affinis*, Ag.	C
PÆCILODUS? Eg.	,,
P. *Rankinii*, Ag.	,,
PLEUROGOMPHUS *auriculatus*, Ag.	,,
PSAMMODUS *cornutus*, Ag.	,,
PÆCILODUS *aliformis*, M'Coy	,,
angustus, Ag.	,,
Attheyi, Barkas	,,
convolutus, N. & W.	,,
foveolatus, M'Coy	,,
Jonesii, Ag.	,,
P. *transversus*, Ag.	,,
P. *obliquus*, Ag.	,,
ornatus, N. & W.	,,
rossicus, Keys.	,,
rugosus, N. & W.	,,
POLYRHIZODUS *dentatus*, N. & W.	,,
Littoni, N. & W.	,,
magnus, M'Coy	,,
ponticulus, N. & W.	,,
porosus, N. & W.	,,
pusillus, M'Coy	,,
radicans, Ag.	,,
PETALODUS *radicans*, Ag.	,,
rectus, Ag.	,,
P. *truncatus*, N. & W.	,,
PRIONOCANTHUS *dubius*, Pand.	S
PRISTACANTHUS *marinus*, Eich	D
PRISTICLADODUS *dentatus*, M'Coy	C
Goughii, M'Coy	,,
PRISTODUS *falcatus*, Ag.	,,
PSAMMODUS *angularis*, N. & W.	,,
Goughii, M'Coy	,,
obtusus, Ag.	,,
porosus, Ag.	,,
reticulatus, N. & W.	,,
rhomboideus, N. & W.	,,
rugosus, Ag.	,,
P. *canaliculatus*, M'Coy.	,,
P. *semicylindricus*, N. & W.	,,
PSEPHODUS *magnus*, Ag.	,,
COCHLIODUS *magnus*, Ag.	,,
HELODUS *planus*, Ag.	,,
PTYCHACANTHUS *dubius*, Ag.	D
sublævis, Ag.	C
RABDACANTHUS *truncatus*, Pand.	S
RHYMODUS *transversus*, Ag.	C
PSAMMODUS *cornutus*, Ag.	,,
RINODUS *calceolus*, N. & W.	D
SANDALODUS *angustus*, N. & W.	C
carbonarius, N. & W.	,,
crassus, N. & W.	,,
grandis, N. & W.	,,
lævissimus, N. & W.	,,
parvulus, N. & W.	,,
spatulatus, N. & W.	,,
SPHAGODUS *pristodontus*, Ag.	S
SPHENACANTHUS *serrulatus*, Ag.	C
STENACANTHUS *nitidus*, Leidy	D
STREBLODUS *Colei*, Ag.	,,
COCHLIODUS *oblongus*, Ag.	,,
S. *Egertoni*, Ag.	,,
COCHLIODUS *oblongus*, Ag.	,,
S. *oblongus*, Ag.	,,
COCHLIODUS *oblongus*, Ag.	,,
ROSIPHERUS *indentatus*, Pand.	S
STROSIPHERUS *lævis*, Pand.	S
serratus, Pand.	,,
THELODUS *parvidens*, Ag.	,,
PACHYLEPIS *Glaber*, Pand.	,,
costatus, Pand.	,,
striatus, Pand.	,,
CŒLOLEPIS *lævis*, Pand.	,,
Schmidtii, Pand.	,,
Goebelli, Pand.	,,
carinatus, Pand.	,,
NOSTOLEPIS *striatus*, Pand.	,,
GOMPHODUS *sandelensis*, Pand.	,,
TOMODUS *convexus*, Ag.	C
COCHLIODUS *magnus*, Ag.	,,
TRIGONODUS *major*, N. & W.	,,
minor, N. & W.	,,
TRISTYCHIUS *arcuatus*, Ag.	,,
minor (?), Portlock	,,
WODNIKA *striatula*, Mnstr.	P
ACRODUS *Althausii*, Mnstr.	,,
STROPHODUS *angustus*, Mnstr.	,,
arcuatus, Mnstr.	,,
XENACANTHUS *Decheni*, Kner.	,,
ORTHACANTHUS *Dechenii*, Goldf.	,,
XYSTRACANTHUS *arcuatus*, M. & H.	C
XYSTRODUS *angustus*, Ag.	,,
COCHLIODUS *striatus*, Ag.	,,
X. *occidentalis*, St. John	,,
striatus, Ag.	,,
COCHLIODUS *striatus*, Ag.	,,

RAYS.

BYZENOS *latipinnatus*, Mnstr.	P
DICTEA *striata*, Mnstr.	,,
ACRODUS *larva*, Ag.	,,
JANASSA *angulata*, Mnstr.	,,
bituminosa, Mnstr.	,,
TRILOBITES *bituminosus*, Schloth.	,,
J. *compressus*, Barkas	C
J. *dictea*, Mnstr.	P
Humboldtii, Mnstr.	,,
JANASSA *imbricatus*, H. & A.	C
CLIMAXODUS *imbricatus*, M'Coy	,,
J. *minutus*, Barkas	,,
CLIMAXODUS *minutus*, Barkas	,,
J. *ovatus*, Barkas	,,
CLIMAXODUS *ovatus*, Barkas	,,
C. *linguæformis*, H. & A.	,,
JANASSA *linguæformis*, H. & A.	,,
J. *vermiformis*, Barkas	,,
CLIMAXODUS *vermiformis*, Barkas	,,
RADAMAS *macrocephalus*, Mnstr.	,,

GANOIDS.

ACANTHODES *Bronnii*, Ag.	,,
ACANTHOESSUS *Bronnii*, Ag.	,,
A. *coriaceus*, Eg.	,,
gracilis, Beyr.	P
Mitchelli, Eg.	D
A. *antiquus*, Eg.	,,
A. *Peachii*, Eg.	,,
pusillus, Ag.	,,
sulcatus, Ag.	C
Wardi, Eg.	,,
ACANTHODOPSIS *Egertoni*, H. & A.	,,
ACROLEPIS *acutirostris*, Ag.	,,
angustus, Mnstr.	P
asper, Ag.	,,
A. Sedgwickii, Quenstedt	
Dunkeri, Germ.	

PALÆONISCUS *Dunkeri*, Germ.	P
GYROLEPIS *asper*, Ag.	,,
ACROLEPIS *exsculptus*, Mnstr.	,,
PALÆONISCUS *exsculptus*, Germ.	,,
ACROLEPIS *ornatus*, Mnstr.	,,
A. *giganteus*, Mnstr.	,,
Hopkinsi, M'Coy	C
HOLOPTYCHIUS *Hopkinsi*, M'Coy	,,
Hortonensis, Dawson	,,
intermedius, Mnstr.	P
macroderma, Eich.	D
Murchisoni, Fisch.	P
TETRAGONOLEPIS *Murchisoni*, Fisch.	,,
reticulatus, Eich.	D
rhombifera, Eich	P
Sedgwickii, Ag.	,,
PALÆONISCUS, Sedg.	,,
n. sp., Aitkin	C
AMBLYPTERUS *anconoæchmodus*, [Walker	,,
A. *eupterygius*, Ag.	,,
PALÆOTHRISSUM *eupterygium*, Ag.	
A. *lateralis*, Ag.	,,
PALÆOTHRISSUM *laterale*, Ag.	
A. *latus*, Ag.	,,
PALÆOTHRISSUM *latum*, Ag.	
A. *macropterus*, Ag.	,,
PALÆONISCUM *macropterum*, Bronn.	
PALÆOTHRISSUM *dorsale*, Ag.	
A. *nemopterus*, Ag.	,,
Olfersi, Ag.	P
Portlocki, Eg.	C
punctatus, Ag.	,,
striatus, Ag.	,,
AMPHICENTRUM *granulatum*, [Hux.	,,
striatum, H. & A.	,,
ARCHÆONECTES *pertusus*, H. v. [Mey.	D
ARCHICHTHYS *sulcidens*, H. & A.	,,
ASTERACANTHUS *siderius*, M. & H.	C
ASTEROLEPIS *Bohemicus*, Barr.	S
concatenatus, Eich.	D
ASTEROLEPIS *minor*, Ag.	,,
ACTINOLEPIS *tuberculatus*, Ag.	,,
CHELYOPHORUS *pustulatus*, Ag.	,,
PTERICHTHYS, *depressus*, Eich.	,,
concatenatus, Eich.	,,
A. *depressa*, Eich.	,,
Hæninghausi, Ag.	,,
Malcolmsoni, Ag.	,,
ornata, Eich.	,,
ASTEROLEPIS *apicalis*, Eich.	,,
Asmussi, Ag.	,,
granulata, Eich.	,,
speciosa, Eich.	,,
CHELONICHTHYS *Asmussii*, Ag.	,,
PTERICHTHYS *Harderi*, Pand.	,,
elegans, Pand.	,,
COCCOSTEUS *maximus*, Ag.	,,
A. *verrucosa*, M'Coy	C
AUCHENASPIS *Egertoni*, Lank.	D
Salteri, Eg.	,,
AULACOSTEUS *oviformis*, Eich	,,
PTYCTODUS *uncinatus*, Pand.	,,
A. *cochleariformis*, Eich.	,,
PTYCTODUS *obliquus*, Pand.	,,
BOTHRIOLEPIS *favosa*, Ag.	,,
DENDRODUS *favosus*, Eich.	,,
GLYPTOSTEUS *favosa*, Ag.	D
BOTHRIOLEPIS *ornata*, Eich.	,,
GLYPTOSTEUS *reticulatus*, Ag.	,,
CAMPYLOPLEURON, Hux.	C
CATOPTERUS *anguilliformis*, Redf.	P
gracilis, Redf.	,,
parvulus, Redf.	,,
Redfieldi, Eg.	,,
CEPHALASPIS *Dawsoni*	D
Lewisii, Ag.	,,
Lightbodii, Lank.	,,
Lloydii, Ag.	,,
Lyelli, Ag.	,,
Schrenkii, Pand.	S
CEPHALOPTERUS *Pagei*, Powr.	D
CERATODUS, Ag.	C
CHEIRACANTHUS *grandispinus*, [M'Coy	D
C. *lateralis*, M'Coy	,,
latus, Eg.	,,
microlepidotus, Ag.	,,
minor, Ag.	,,
Murchisoni, Ag.	,,
pulverulentus, M'Coy	,,
CHEIROLEPIS *Cummingiæ*, Ag.	,,
C. *curtus*, M'Coy	,,
C. *posthumus*, Eich.	,,
Trailli, Ag.	,,
C. *velox*, M'Coy	,,
macrocephalus, M'Coy	,,
C. *uragus*, Ag.	,,
CHELYOPHORUS *primigenius*, Eich.	,,
reticulatus, Ag.	,,
Verneuillii, Ag.	,,
CLIMATIUS *acutatus*, Eich.	,,
scutiger, Eg.	,,
BRACHYACANTHUS *scutiger*, Eg.	,,
ICTINOCEPHALUS *granulatus*, Page	
C. *uncinatus*, Eg.	,,
HOMACANTHUS *arcuatus*, Ag.	,,
gracilis, Eich.	
HYBODUS *gracilis*, Eich.	
CLEITHROLEPIS *granulatus*, Eg.	C (?)
COCCOPELTUS *Asmussi*, Pand.	S
COCCOSTEUS *Agassizii*, Barr.	,,
carbonarius, M'Coy	C
cuspidatus, Ag.	D
decipiens, Ag.	,,
C. *latus*, Ag.	,,
C. *microspondylus*, M'Coy	,,
C. *trigonaspis*, M'Coy	,,
C. *Milleri*, Ag.	,,
oblongus, Ag.	,,
obtusus, Pand.	,,
primus, Barr.	S
pusillus, M'Coy	D
C. *minor*, Miller	,,
CŒLACANTHUS *caudalis*, Eg.	P
elegans, Newb,	C
elongatus, Hux.	,,
gracilis, Ag.	P
granulosus, Ag.	,,
Hassiæ, Mnstr.	,,
lepturus, Ag.	C
Munsteri, Ag.	,,

CŒLACANTHUS *ornatus*, Newb.	C
Phillipsii, Ag.	,,
robustus, Newb.	,,
COLONODUS *longidens*, M'Coy	,,
striatulus, M'Coy	,,
CONCHIOPSIS *exanthematicus*, Cope	,,
filiferus, Cope	,,
CONCHODUS *ostreiformis*, M'Coy	,,
plicatus, Dawson	,,
CONCHOPOMA *gadiforme*, Kner.	P
CRICODUS *incurvus*, Ag.	D
DENDRODUS *incurvus*, Ow.	,,
POLYPLOCODUS *incurvus*, Pand.	,,
C. *Horneri*, Ag.	C
CTENODUS *alatus*, Ag.	,,
asteriscus, Ag.	D
concavus, Barkas	C
corrugatus, H. & A.	,,
cristatus, Ag.	,,
elegans, H. & A.	,,
ellipticus, H. & A.	,,
imbricatus, H. & A.	,,
interruptus, Barkas	,,
monocerus, Barkas	,,
Murchisoni, Ag.	
obliquus, H. & A.	,,
SAGANODUS *inæqualis*, Owen	,,
C. *obtusus*, Barkas	,,
octodorsalis, Barkas	,,
ovatus, Barkas	,,
quadratus, Barkas	,,
Robertsoni, Ag.	,,
tuberculatus, H. & A.	,,
n. sp. ined., Barkas	,,
CYATHASPIS *Banksii*, H. & S.	D
PTERASPIS *Banksii*, H. & S.	,,
C. *Symondsi*, Lank.	,,
CYPHOMALEPIS *Egertoni*, Pand.	S
CYCLOPTYCHIUS *carbonarius*, Hux.	C
DENDROPTYCHIUS, Hux.	,,
DENDRODUS *acutatus*, Pand.	D
inflexus, Eich.	,,
SAURICHTHYS *inflexus*	,,
DENDRODUS *sigmoideus*, Owen	,,
D. *lævis*, Gieb.	S
latus, Owen	D
D. *strigatus*, Owen	,,
D. *minor*, Ag.	,,
tenuistriatus, Ag.	,,
DICTYOPYGE *macrura*, Eg.	C (?)
CATOPTERUS *macrurus*	
DIDYMASPIS *Grindrodi*, Lank.	D
DINICHTHYS *Herzeri*, Newb.	,,
DIPLACANTHUS *crassispinus*, Ag.	,,
gibbus, M'Coy	,,
gracilis, Eg.	,,
ICTINOCEPHALUS *granulatus*, Page	,,
D. *longispinus*, Ag.	,,
perarmatus, M'Coy	,,
striatulus, Ag.	,,
striatus, Ag.	,,
DIPLOPTERAX *affinis*, M'Coy	,,
DIPLOPTERUS *affinis*, Ag.	,,
D. *Agassizii*, M'Coy	,,
DIPLOPTERUS *Agassizii*, Traill	,,

DIPLOPTERAX *borealis*, M'Coy	D
DIPLOPTERUS *borealis*, Ag.	,,
D. *gracilis*, M'Coy	,,
DIPLOPTERUS *gracilis*, M'Coy	,,
D. *macrolepidotus*, M'Coy	,,
DIPLOPTERUS *macrocephalus*, Ag.	,,
DIPTERUS *macrolepidotus*, S. & M.	,,
DIPLOPTERUS *carbonarius*, Ag.	C
Robertsoni, Ag.	,,
DIPTERONOTUS *cyphus*, Eg.	D
DIPTERUS *arenaceus*, Eich.	,,
glaber, Pand.	,,
macrolepidotus, Sedg. & [Mur.	,,
marginalis, Pand.	,,
CTENODUS *marginalis*, Ag.	,,
D. *Murchisoni*, Pand.	,,
platycephalus, Pand.	,,
POLYPHRACTUS *platycephalus*, Ag.	,,
D. *radiatus*, Eich.	,,
CTENODUS *radiatus*, Eich.	,,
Worthii, Ag.	,,
D. *serratus*, Eich.	,,
DIPTERUS *Keyserlingii*, Pand.	,,
CTENODUS *Keyserlingii*, Ag.	,,
serratus, Eich.	,,
D. *tuberculatus*, Pand.	,,
CTENODUS *parvulus*, Ag.	,,
D. *Verneuillei*, Pand.	,,
DORYPTERUS *Hoffmanii*, Germ.	P
ELONICHTHYS *crassidens*, Gieb.	C
Germari, Gieb.	,,
lævis, Gieb.	,,
peltigerus, Newb.	,,
EUCEPHALASPIS *Agassizii*, Lank.	D
CEPHALASPIS *Agassizii*	,,
E. *asper*, Lank.	,,
Lyelli, Ag.	,,
CEPHALASPIS *Lyelli*, Ag.	,,
E. *Pagei*, Lank.	,,
Powriei, Lank.	,,
CEPHALASPIS *Lyelli*, Ag.	,,
EUKERASPIS *pustuliferus*, Ag.	S
SCLERODUS *pustuliferus*, Ag.	,,
PLECTRODUS *mirabilis*, Ag.	,,
pleiopristis, Ag.	,,
EURYLEPIS *granulatus*, Newb.	C
ovoideus, Newb.	,,
tuberculatus, Newb.	,,
EURYNOTUS *crenatus*, Ag.	,,
fimbriatus, Ag.	,,
EURYSOMUS *macrurus*, Young	P
PLATYSOMUS *macrurus*, Ag.	,,
EUTHACANTHUS *curtus*, Powr.	D
elegans, Powr.	,,
gracilis, Powr.	,,
grandis, Powr.	,,
MacNicoli, Powr.	,,
GANORHYNCHUS *Woodwardi*, Traq.	C ?
GLOBULODUS *elegans*, Mnstr.	P
GLYPTOLEPIS *microlepidotus*, Ag.	D
orbis, Eich.	S
G. *leptopterus*, Ag.	,,
G. *quadratus*, Eich.	D
G. *elegans*, Ag.	,,
GLYPTOLÆMUS *Kinnairdi*, Hux.	,,
GLYPTOPOMUS *minor*, Ag.	,,
PLATYGNATHUS *minor*, Ag.	,,

GOMPHOLEPIS *Panderi*, Barr.	S
GRAPTOLEPIS *ornatus*, Ag.	C
GYROLEPIS *maximus*, Ag.	,,
Rankinei, Ag.	,,
GYROPTYCHIUS *angustus*, M'Coy	D
diplopteroides, M'Coy	,,
HEMICYCLASPIS *Murchisoni*, Lank.	,,
CEPHALASPIS *Murchisoni*, Eg.	,,
ornatus, Eg.	,,
HETEROSTEUS *eurynotus*, Asm.	,,
Icthyosauroides, Kutorga	,,
H. *convexus*, Asm.	,,
gracilior, Asm.	,,
Hueckii, Asm.	,,
ingens, Asm.	,,
initialis, Asm.	,,
Kutorgæ, Asm.	,,
secundarius, Asm.	,,
HOLACANTHODES *gracilis*, Beyrich	P
HOLASPIS *sericeus*, Lank.	D
HOLOPTYCHIUS *Andersoni*, Ag.	,,
H. *Flemingii*, Ag.	,,
H. *falcatus*, Ag.	C
Garneri, Murch.	,,
giganteus, Ag.	D
GYROLEPIS *giganteus*, Ag.	,,
HOLOPTYCHIUS *Americanus*, Leidy	,,
H. *Murchisoni*, Ag.	,,
nobilissimus, Ag.	,,
Omaliusii, Ag.	,,
Portlocki, Ag.	C
princeps, M'Coy	D
sauroides, Ag.	C
Sedgwicki, M'Coy	D
striatus, Ag.	C
HOMOSTEUS *cataphractus*, Asm.	D
formossissimus, Asm.	,,
latus, Asm.	,,
ponderosus, Asm.	,,
HOMOTHORAX *Flemingii*, Ag.	,,
HOPLOPYGUS *Binneyi*, Ag.	C
ISCHYPTERUS *Agassisii*, Redf.	P
fultus, Redf.	,,
PALÆONISCUS *fultus*, Ag.	,,
macropterus, Redf.	,,
I. *latus*, Redf.	,,
PALÆONISCUS *latus*, Redf.	,,
EURYNOTUS *tenuiceps*, Ag.	,,
I. *macropterus*, Redf.	,,
ovatus, Redf.	,,
ISODUS *leptognathus*, M'Coy	,,
LAMNODUS *biporcatus*, Owen	D
DENDRODUS *biporcatus*, Owen	,,
L. *hastatus*, Ag.	,,
L. *Panderi*, Ag.	,,
DENDRODUS *hastatus*, Owen	,,
compressus, Owen	,,
I. *sulcatus*, Ag.	,,
MACROPETALICHTHYS *Agassisii*, [Meyer	C
Manni, Newb.	,,
AGASSICHTHYS *Manni*, Newb.	,,
M. *rapheidolabis*, Norwood	,,
Sullivanti, Newb.	,,
AGASSICHTHYS *Sullivanti*, Newb	,,
MEGALICHTHYS, Ag.	,,
CENTRODUS acutus, Gieb.	,
CENTRODUS *striatulus*, M'Coy	C
MEGALICHTHYS *coccolepis*, Young	,,
falcatus, Ag.	,,
Hibberti, Ag.	,,
GANOLODUS *sicula*, Owen	,,
M. *maxillaris*, Ag.	,,
priscus, Ag.	D
APEPODUS *priscus*, Leidy	C
M. *rugosus*, Young	,,
tuberculatus, Barkas	,,
MENASPIS *armata*, Eich.	D
MESOLEPIS *scalaris*, Young	C
Wardi, Young	,,
MYRIOLEPIS *Clarkei*, Eg.	,, ?
OMMATOLAMPES *Eichwaldi*, Fisch.	,,
ONISCOLEPIS *dentatus*, Pand.	S
magnus, Pand.	,,
ONYCHODUS *Hopkinsii*, Newb.	C
OROGNATHUS *conidens*, Ag.	,,
ORTHOGNATHUS *reticulosus*, Barkas	,,
OSTEOLEPIS *arenatus*, Ag.	D
brevis, M'Coy	,,
Fischeri, Eich.	,,
MEGALICHTHYS *Fisheri*, Eich.	,,
O. *intermedius*, Eich.	,,
STIGMOLEPIS *Owenii*, Pand.	S
MELITTOMALEPIS *elegans*, Pand.	,,
DASYLEPIS *Keyserlingii*, Pand.	,,
DICTYOLEPIS *Bronnii*, Pand.	,,
O. *major*, Ag.	,,
macrolepidotus, Ag.	,,
microlepidotus, Ag.	,,
nanus, Eich.	,,
OSTEOPLAX *erosus*, M'Coy.	C
PALÆONISCUS *Abbsii*, Kirkby	P
Agassisii, Redf.	C
Alberti, Jackson	,,
altus, Kirkby	P
angustus, Ag.	,,
antipodeus, Eg.	C(?)
arcuatus, Eg.	,,
Beaumonti, Eg.	,,
Blainvillei, Ag.	,,
PALÆOTHRISSUM *inæquilobum*, Blain.	,,
parvum, Blain.	
P. *Brainardi*	,,
carinatus, Ag.	,,
catopterus, Ag.	P
caudatus, Hecker	,,
comptus, Ag.	C & P
PALÆOTHRISSUM *magnum*, Sedg.	
macrocephalum, Sedg.	
P. *costatus*, Eich.	P
decorus, Eg.	C
Duvernoy, Ag.	,,
Egertoni, Ag.	,,
GANACRODUS *hastula*, Owen	,,
P. *elegans*, Sedg.	P
PALÆOTHRISSUM *elegans*, Sedg.	,,
P. *elongatus*, Troschel	C
Frieslebeni, Ag.	P
PALÆONISCUM *Frieslebense*, Blain.	
PALÆONISCUS *megacephalus*, Germ.	
PALÆOTHRISSUM *Frieslebense*, Blain.	
macrocephalum, Blain.	
blennoides, Hall.	
inæquilobum, Huot.	
æquilobum, Huot.	

PALÆOTHRISSUM *vulgatissimum*, Ag.	
CLUPEA *Lametherii*, Blain.	
ACCIPENSER *bituminosus*, Germ.	
ICHTHYOLITHES *eislebensis*, Scheuhzer	
PALÆONISCUS *Gelberti*, Goldf.	C
gibbus, Troschel	,,
glaphyrus, Ag.	P
gracilis, N. & W.	C
Hancocki, Atthey.	,,
kablikæ, Geinitz.	?
lepidurus, Ag.	C
longissimus, Ag.	P
macrophthalmus, Ag.	,,
macropomus, Ag.	,,
PALÆOTHRISSUM *gigas*, Ag.	,,
P. *magnus*, Ag.	,,
PALÆOTHRISSUM *magnum*, Blain.	
PALÆONISCUS *megacephalus*, Kurtze.	
P. *minutus*, Ag.	C
PALÆOTHRISSUM *minutum*, Ag.	,,
P. *monensis*, Eg.	,,
nanus, Eich.	P
obliquus, Hecker.	,,
opisthopterus, Troschel	C
ornatissimus, Ag.	,,
ornatus, Mnstr.	P
ovatus, Redf.	C
peltigerus, Newb.	,,
pygmæus, Meyer.	P
Reussi, Hecker.	,,
Robisoni, Hibb.	C
Scheufkini, Fischer.	P
scutigerus, Newb.	C
speciosus, Mnstr.	P
striatus,	C
striolatus, Ag.	,,
Stschurowskii, Fisch.	P
TRACHELACANTHUS *Stschurowskii*	,,
P. *tenuicaudus*, Troschel	C
tuberculatus, Eich.	P
varians, Kirkby.	,,
Vratislaviensis, Ag.	,,
Voltzii, Ag.	C
Wardi, Hux.	,,
PAMPHRACTUS *Andersoni*, Ag.	D
PAREXUS *incurvus*, Ag.	,,
falcatus, Powr.	,,
PEPLORHINA *anthracina*, Cope	C
PHANEROPLEURON *Andersoni*, Hux.	D
PHLEBOLEPIS *elegans*, Pand.	S
PHYLLOLEPIS *concentricus*, Ag.	D
Portlockii, Ag.	C
tenuissimus, Ag.	D
PLACOTHORAX *Agassizii*, Meyer.	,,
paradoxus, Ag.	,,
PLATYGNATHUS *Jamesoni*, Ag.	,,
CHIASTOLEPIS *clathratus*, Eich.	
P. *paucidens*, Ag.	,,
PLATYSOMUS *Althausii*, Mnstr.	P
biarmicus, Eich.	P
circularis, N. & W.	C
declivus, Ag.	,,
Fischeri, Arnd.	P
Forsteri, H. & A.	C
PLATYSOMUS *Fuldai*, Mnstr.	P
gibbosus, Ag.	C
STROMATEUS *gibbosus*, Blain.	
angulatus, Germ.	
RHOMBUS *minor*, Scheuchzer	
diluvianus minor, Wolfarth	
P. *intermedius*, Mnstr.	P
macrurus, Ag.	,,
UROPTERYX *undulatus*, Ag.	
P. *parvulus*, Ag.	C
parvus, Ag.	P
rhombus, Ag.	,,
STROMATEUS *major*, Blain.	
Knorrii, Germ.	
RHOMBUS *diluvianus major*, Wolfarth	
P. *rotundus*, H. & A.	C
striatus, Ag.	P
UROPTERYX *striatus*, Ag.	
PLECTROLEPIS *rugosus*, Ag.	C
PODODUS *capitatus*, Ag.	,,
PSAMMOSTEUS *arenatus*, Ag.	D
PLACOSTEUS *arenatus*, Ag.	,,
CHEIROLEPIS *splendens*, Eich.	,,
LOPHOSTEUS *superbus*, Pand.	S
ONISCOLEPIS *serratus*, Pand.	,,
crenulatus, Pand.	,,
P. *granulatus*, M'Coy	C
mæandrinus, Ag.	D
PLACOSTEUS *mæandrinus*, Ag.	,,
MICROLEPIS *lepidus*, Eich.	
exilus, Eich.	
CTENACANTHUS *serrulatus*, Ag.	D
ornatus, Eich.	D & C
P. *paradoxus*, Ag.	,,
PSAMMOLEPIS *paradoxus*, Ag.	,,
SCLEROLEPIS *decoratus*, Eich.	
P. *undulatus*, Ag.	,,
PLACOSTEUS *undulatus*, Ag.	,,
CHEIROLEPIS *unilateralis*, Eich.	,,
P. *vermicularis*, M'Coy	C
PTERASPIS *Crouchii*, Salter	D
Mitchelli, Powrie	,,
rostratus, Ag.	,,
CEPHALASPIS *rostratus*, Ag.	,,
PTERICHTHYS *arenatus*, Ag.	,,
cancriformis, Ag.	,,
cellulosus, Pand.	,,
cornutus, Ag.	,,
hydrophilus, Eg.	,,
PAMPHRACTUS *hydrophilus*, Ag.	,,
P. *latus*, Ag.	,,
macrocephalus, Eg.	,,
major, Ag.	,,
ASTEROLEPIS *major*, Eich.	,,
P. *Milleri*, Ag.	,,
oblongus, Ag.	,,
productus, Ag.	,,
quadratus, Eg.	,,
striatus,	,,
testudinarius, Ag.	,,
PYGOPTERUS, *Bonnardi*, Ag.	C
Bucklandi, Ag.	,,
Greenockii, Ag.	,,
Humboldtii, Ag.	P
PALÆOTHRISSUM *magnum*, Blain.	
ESOX *eislebensis*, Blain.	
P. *Jamesoni*, Ag.	C
latus, Eg.	
mandibularis, Ag.	P

P. *scoticus*, Bronn.	P
SAUROPSIS *scoticus*, Ag.	
NEUROPTERYX *mandibularis*, Ag.	
RHIZODOPSIS *granulatus*, Ag.	C
HOLOPTYCHIUS *granulatus*, Ag.	"
R. *sauroides*, Williamson	"
DITTODUS *parallelus*, Owen	"
GANALODUS *Craggesii*, Owen	"
CHARACODUS *confertus*, Owen	"
GASTRODUS *præpositus*, Owen	"
RHIZODUS *angustus*.	
ferox, Owen	"
gracilis, M'Coy	"
R. *Hardingi*, Dawson	"
Hibberti, Owen	"
HOLOPTYCHIUS *Hibberti*, Ag.	"
R. *lanceiformis*, Newb.	"
MIOGANODUS *laniaris*, Owen	"
R. *lancifer*, Dawson	"
occidentalis, N. & W.	"
Portlocki, Ag.	"
RHOMBOPTYCHIUS, Hux.	"
RYTIDOLEPIS *Quenstedtii*, Pand.	S
SAURICHTHYS *Indicus*, Kon.	C
SCAPHASPIS *cornubicus*, M'Coy	D
S. *Dunensis*, Roem.	"
PTERASPIS *Dunensis*, Hux.	"
ARCHÆOTEUTHIS *Dunensis*, Roem.	
S. *Knerii*	"
SCAPHASPIS *Lloydii*, Ag.	D
CEPHALASPIS *Lloydii*, Ag.	"
Lewisii, Ag.	"
PTERASPIS *Lloydii*, Kner	"
S. *Ludensis*, Salter	"
PTERASPIS *Ludensis*, Salter	"
S. *rectus*, Lank.	"
PTERASPIS *Lewisii*	"
S. *truncatus*, Hux.	"
PTERASPIS *truncatus*, H. & S.	"
SCHIDIOSTEUS *mustelensis*, Pand.	S
SCLEROCEPHALUS *Häuseri*, Goldf.	C
STREPSODUS *sauroides*, Hux.	"
HOLOPTYCHIUS, *sauroides*, Ag.	"
GANALODUS *undatus*, Owen	"
THYESTES *verrucosus*, Eich.	D
CEPHALASPIS *verrucosus*, Eich.	"
ODONTODUS *Roodzikullensis*, Pand.	S
TOLYPELEPIS *undulatus*, Pand.	"
TRACHYLEPIS *formosus*, Pand.	"
TRIPLOPTERUS *Pollexfeni*, M'Coy	D
TRIPTERUS *Pollexfeni*, M'Coy	"
TRISTYCHOPTERUS *alatus*, Eg.	"
URONEMUS *lobatus*, Ag.	C
magnus, Traq.	"
UROSTHENES *australis*, Dana	"(?)
ZENASPIS *Salweyi*, Lank.	D
CEPHALASPIS *Salweyi*, Eg.	"
asterolepis, Hux.	"

LIST OF WORKS, ETC., IN WHICH REFERENCES TO THE ABOVE FISHES OCCUR.

AGASSIZ. Poissons fossiles.
— Poissons du Vieux Grès-Rouge.
BARKAS. Coal-Measure Palæontology.
BUCKLAND. Mineralogy and Geology.
DAWSON. Acadian Geology.
DE KONINCK. Description des Animaux fossiles.
EICHWALD. Lethæa Rossica.
GIEBEL. Fauna der Vorwelt.
KING. Permian Fossils.
LYELL. Student's Elements of Geology.
M'COY. British Palæozoic Fossils.
MILLER. Footprints of the Creator.
— Old Red Sandstone.
— Popular Geology.
MORRIS. British Fossils.
MÜNSTER. Beiträge zur Petrefactenkunde.
MURCHISON. "Siluria."
— Silurian System.
OWEN. Dental Characters of Genera and Species of Coal-Measure Fishes and Reptiles.
— Odontography.
— Palæontology.
PANDER. Monographie der Fossilen Fische des Silurischen Systems der Russich-Baltischen Gouvernements.
— Ueber die Placodermen des Devonischen Systems.
— Ueber die Ctenodipterinen des Devonischen Systems.
PANDER. Ueber die Saurodipterinen, Dendrodonten, Glyptolepiden und Cheirolepiden des Devonischen Systems.
PICTET. Traité de Paléontologie.
PORTLOCK. Geological Report of Londonderry and Tyrone.
American Journal of Science.
Annals and Magazine of Nat. History.
English Mechanic.
Geologist.
Geological Magazine.
Geological Survey of Illinois.
Memoirs of the Geological Survey of Great Britain.
Monthly Review of Dental Surgery.
Proceedings of the Academy of Natural Sciences of Philadelphia.
Proceedings of the Geological Society London.
Proceedings of the Palæontographical Society.
Quarterly Journal of Geological Society London
Report of the United States Geological Survey of the Territories (Vertebrata) 1873.
Science Gossip.
Scientific Opinion.
Transactions of the Geological Society of London.
Transactions of the Northumberland and Durham Nat. Hist. Soc.
Transactions of the Tyneside Naturalists' Field Club.
Transactions of the Philosophical Society.

IV.—DESCRIPTIONS OF NEW CORALS FROM THE CARBONIFEROUS LIMESTONE OF SCOTLAND.

By JAS. THOMSON, F.G.S.
Corr. Memb. R. Soc. Sci. Liège, Belgium.

(PLATE XX.)

HAVING been engaged for many years in collecting and studying the corals of the Mountain Limestone of Scotland, I propose, in the present communication, to describe some of the new species which have come under my notice. Some of these were discovered in a thin bed of shale from five to nine inches thick, which overlies the low post of limestone in Trearn Quarry, near Beith, Ayrshire. Indeed, this horizon throughout Great Britain may be safely said to be the zone in which simple corals existed in greater abundance, and attained greater dimensions, than in any other section of the Mountain Limestone. There are a few forms found in the upper members of the period. So far, however, as my investigations have gone, these are limited both in genera and species; and, with only one or two exceptions, are all more or less simple in their organization. It is not my intention at present to enter into any elaborate stratigraphical arrangement of beds, or classification, or distribution of the different genera or species. That will form matter for a memoir, in which I hope to delineate not only the almost imperceptible gradation from one species into another, but also the persistent modifications that occur between the different genera. Indeed, those modifications are so constant, that it often becomes difficult to say where one genus begins, and its next ally ends. This is a result that can only be safely attained by examining an extensive collection of specimens, all of which must be sectioned with great care. From my own personal observations, assisted by my friends, I shall be able to note the stratigraphical distribution of the genera and species throughout the three kingdoms. Such a memoir is a great desideratum; and it can only be prepared from personal investigation and examination of sections. Only thus can we ascertain in what condition the genera and species are found.

In the mean time, I intend giving brief descriptions of some new genera and species which I have discovered. Some of these have been noticed in my Reports on the investigations into the Mountain Limestone Corals, in the Reports of the British Association. And here I beg to acknowledge the kindness of the Council of the Association, shown in their making money grants to assist me in my investigations.

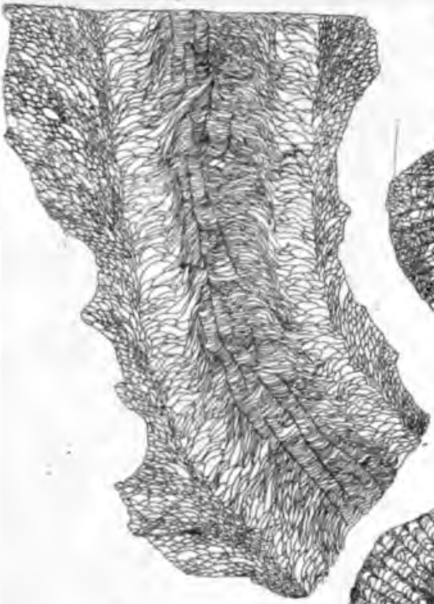
Family: CYATHOPHYLLIDÆ.

Tribe: RODOPHYLLESIA.

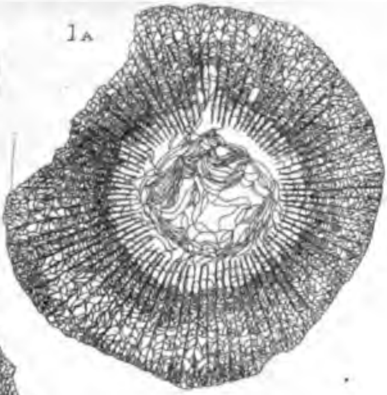
Genus: *Rodophyllum.*

Generic characters.—Corallum cylindro-conical, usually tall, frequently from eight to ten inches long; curved, and presenting well-marked accretion ridges, Epitheca thin and smooth. Calice circular, shallow, and slightly everted. Septa thin, numerous, and formed

Fig. 1



1A



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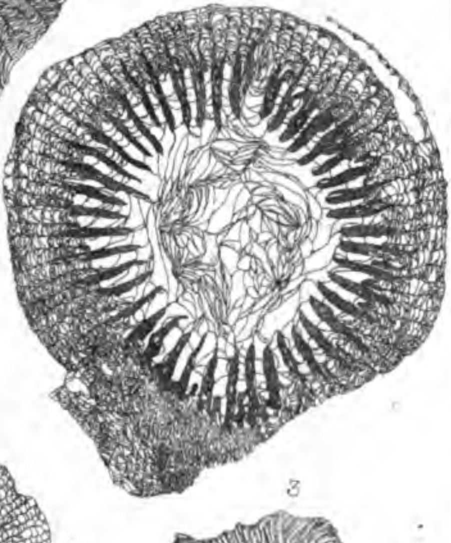
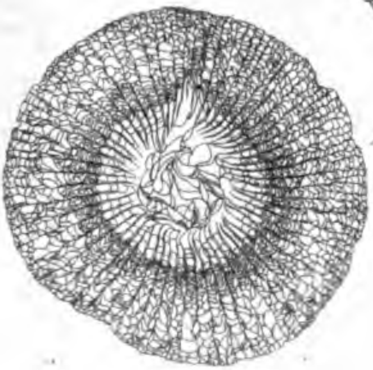
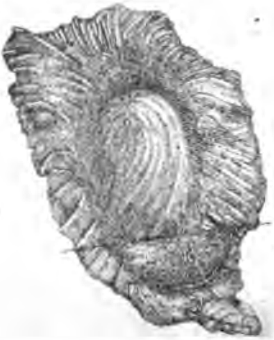


3A

4



3



Jas. Thomson [illegible]

[illegible] Lechner

by well-developed thin laminæ for about two-thirds of their length from the inner margin; while in the outer margin they become single and flexuous. Columellarian boss dome-shaped, and slightly raised above the inner margin of the primary septa, and clasped by sub-convolute ridges.

I have established this genus for the reception of a group of corals which I discovered many years ago in Trearn quarry, and in Poneil Water, near Lesmahagow, Lanarkshire. The passage from the earlier stages of growth to maturity or an average size, in this genus, presents some interesting details. In the earlier stages the septa are bounded by a thick epitheca, and the dissepiments that fill up the interseptal spaces are sparsely developed. (See Pl. XX. Figs. 3 and 3*a*.) The septa are also thicker than they are in a more mature coral, or until they become more cylindrical in outline. Then they become thinner and more flexuous towards the outer margin, and an increase of dissepiments is observed. In a young coral the lamellæ are sub-convolute, and fold round, clasping the rotund boss that fills up the centre of the calicular cavity. (See Pl. XX. Fig. 3.) It is like an unexpanded rose-bud, from which I take the generic name. But increase in size shows the lamellæ less convolute, and presents an aspect similar to the petals of a rose in an advanced stage of expansion. They stretch across the centre space, and become less convolute. In an average-sized coral the lamellæ pass across the centre of the calice at various angles, thus presenting, when exposed in a transverse section, an almost confused mass of cellular structure.

In a mature specimen the coral presents a uniformity of thickness for six to eight inches of its length, is more or less marked with constrictions, and exhibits a corresponding diminution or augmentation of the number of the dissepiments which fill up the interseptal spaces. This will be better understood by referring to Pl. XX. Fig. 1.

Rodophyllum Craigianum, Thomson. sp. nov. Pl. XX. Fig. 1 and 1*a*.

Specific characters.—Corallum cylindro-conical, very tall, curved, and marked with broad accretion ridges. Calice circular, slightly everted, two inches in diameter. Columellarian boss rotund, slightly raised above the inner margin of the primary septa, and crowned with sub-convolute lamellæ. Septa numerous, straight, thin, and formed by distinct laminæ for two-thirds of their length from the inner margin. There they become single and flexuous;—there are 88 primary, and an equal number of secondary. The latter pass inwards from the epitheca for about one line in length; they then bend and become attached to the primary septa. Each is laterally united by numerous minute angular dissepiments. Central area eight lines broad, formed by sub-convolute plates. Fossula with two short septa in it, these are bound to the central mass by two plates passing into it. In a longitudinal section no columellarian line is seen passing down the centre, as in some closely allied forms. A series of lamellar plates passes downwards at various angles for a short distance, and are laterally united by *concave dissepiments*. The intermediate area is filled in by convex plates; while the outer area, or interseptal spaces, is filled up with minute convex dissepiments. Convexity upwards and outwards.

This coral equals in size what has been termed *Zephrentis cylindrica*, and has even been classified as such. If, however, sections are made and examined, it is clearly seen to be excluded from all existing genera. It is dedicated to that indefatigable explorer of Ayrshire fossil-beds, and excellent geologist, Mr. Robert Craig. He has uniformly aided me by assiduously laying aside many specimens which otherwise would have been buried in the quarry débris, and I beg to offer him my thanks for all his kindness.

Height of corallum 10 in.; diameter of calice 2 in. Position near the base of the Carboniferous Limestone, in a thin bed of shale, in Trearn Quarry, near Beith, Ayrshire.

Rodophyllum Slimonianum, Thomson. sp. nov. Pl. XX. Fig. 2.

Specific characters.—Corallum cylindro-conical, curved, with small accretion ridges. Calice circular. Septa 44 primary, which at their inner margin, and for half their length, are more or less clavate, and cellular. The septa on the outer half, passing to the wall, are thin and flexuous, with an equal number of long, slender secondary septa which pass inwards more than half the length of the primary septa. Each is laterally united by numerous angular dissepiments. The fossula has three short septa in it, and a portion of the endotheca of the central mass passes into it. The specimen, being only a fragment, does not warrant me in giving more details; but the clavate termination of the primary septa clearly excludes it from any known species.

Height of corallum unknown; diameter of calice 2 in. 5 lines; diameter of columellarian space 1 in. The specimen was found at Brockley, Lesmahagow, in the lower beds of the Carboniferous Limestone, by Mr. Robert Slimon, Surgeon. He has long and carefully worked out the geology of the upper ward of Lanarkshire. To him I owe the use of the specimen, and I dedicate the species to him.

Rodophyllum simplex, Thomson. sp. nov. Pl. XX. Figs. 3 and 3*a*.

Specific characters.—Corallum turbinate, curved. Calice moderately deep and circular. Columellarian boss rotund, and crowned with sub-convolute lamellæ. Septa not very well defined—the specimen being imperfect, I have no data to determine exactly their number and arrangement. The epitheca and septa are eroded away on the concave side by atmospheric agencies. If, however, these details are wanting, we are compensated by having the columellarian boss exposed to near the lower extremity of the coral, and this enables us to form a correct idea of its form, and of the arrangement of the lamellæ. It is rotund in outline, and resembles an unexpanded rose-bud.

Height of corallum about 1¾ in. The coral is found at Brockley, Lesmahagow, in a band of shale interstratified between thin beds of Limestone, and is associated with numerous other corals.

Rodophyllum Phillipsianum, Thomson. sp. nov. Pl. XX. Fig. 4.

Specific characters.—Corallum turbinate, short, and marked with small accretion ridges. Calice circular, moderately deep. Columellarian boss rotund, slightly raised above the inner margin of the primary septa, and crowned by sub-convolute lamellæ. Septa numerous, 60 primary, exhibiting well-marked lamina near their inner margin, where they are fusiform, and curve gently towards the fossula, or from left to right. There is an equal number of secondary septa, which pass inwards from the wall for about two lines. There they bend and become united to the primary septa. Each are laterally united with numerous angular dissepiments, which fill up the interseptal spaces.

Height of corallum 2 in.; diameter of calice 1 in. and 11 lines.

This species differs from *Rod. Craigianum* in its turbinate form, and the smallness of the central boss, and in the number and arrangement of the interseptal dissepiments.

Position.—Found in a thin bed of shale overlying the low post of Limestone in Trearn Quarry, near Beith, Ayrshire.

I dedicate this species to the late Prof. John Phillips, F.R.S., as an expression of my appreciation of his uniform urbanity and kindness, nowhere better exemplified than in Section C. at the Meetings of the British Association.

EXPLANATION OF PLATE XX.

Rodophyllum Craigianum.
FIG. 1. The usual appearance of a longitudinal section.
1*a*. A transverse section, natural size.
Rodophyllum Slimonianum.
2. A transverse section, natural size.
Rodophyllum simplex.
3. Corallum with epitheca and septa eroded away, exposing the columellarian boss.
3*a*. A transverse section, natural size.
Rodophyllum Phillipsianum.
4. A transverse section, natural size.

NOTICES OF MEMOIRS.

I.—REPORT ON THE PHYSICAL CHARACTER AND RESOURCES OF GIPPSLAND. By A. J. SKENE and R. BROUGH SMYTH. 8vo. pp. 65. (Melbourne, 1874.)

THIS is an Official Report, made by the Surveyor-General and the Secretary for Mines, to the Hon. J. J. Casey, Minister of Lands and Agriculture for the Colony of Victoria.

The writers describe the general physical features of Gippsland, the soils, timber, the rivers and lakes. The lakes "are full of interest. Occupying extensive but shallow depressions in the great tract of level Tertiary country (which has its limits on the north as far as Kangaroo Creek, a tributary of the River Mitchell, on the west in the tributaries of the La Trobe, and on the east at Ram Head), these waters may be regarded as similar to the pools that are left in the sands when the tide has receded. The laws which govern the flux and re-flux of tides do not, however, govern these. The waters have not diminished nor drawn back. The land has risen. . . . The lakes are being gradually filled with mud and sediment; and every year, with the advance of settlement, the work of filling up will proceed more rapidly."

The principal geological features are described and illustrated by sections. Reference is also made to the mineral wealth of the district. Osmiridium has been collected in small quantities near Stockyard Creek. Gold is being actively worked; while silver, tin, copper, lead, antimony, zinc, bismuth, manganese, molybdenum and iron are met with in places.

II.—A SKETCH OF THE GEOLOGY OF THE ISLE OF MAN. By JOHN HORNE, F.G.S., of the Geological Survey of Scotland. (Trans. Edinburgh Geol. Soc. vol. ii. part 3, 1874.)

THIS is an interesting sketch of the principal features of the geology of the Isle of Man. After indicating the previous literature on the subject, the writer briefly refers to the Silurian rocks, which may be of Lower Llandeilo and Lower Caradoc age. Beds hitherto assigned to the Old Red Sandstone period are included under the heading of the Calciferous Sandstone series, which series, as developed in Scotland, they resemble in lithological characters. The Carboniferous Limestone series, forming three groups, is next described; and then follow descriptions of the igneous rocks. The glacial phenomena of the Isle prove that it has been overflowed by glacier ice. According to Mr. Horne, the Till is in all respects similar to the Scotch Till, and he observes abundant evidence of a strange intermingling of foreign rocks in it, which must have travelled from the coast of Cumberland, the south of Scotland, and the north of Ireland.

III.—LE *PTERODACTYLUS KOCHI* DU MUSÉE TEYLER. Par Dr. T. C. WINKLER. (Haarlem, 1874.)

AMONG the important additions obtained by the Directors of the Teyler Museum, is a tolerably perfect specimen of a Pterodactyle, from the Lithographic Stone of Bavaria, which has been fully described by the indefatigable Curator, Dr. Winkler, in the third volume of the *Archives* of the museum.

The comparatively good state of preservation of the bones of the skeleton has enabled the author to carefully compare them with the bones of those species which have the greatest resemblance to it; these are the *Pt. micronyx*, von Meyer; *Pt. spectabilis*, von Meyer; *Pt. Meyeri*, Münst.; and the *Pt. Kochi*, Wagner. In *P. micronyx* (described in vol. iii. of the same *Archives*, 1870), the metacarpal equals in length the bones of the fore-arm, the metatarsals are small, the first is longer than the three others, even than the fourth; in this specimen the metacarpal bones are shorter than those of the fore-arm, and the metatarsals are even longer and thicker. This specimen differs from *P. spectabilis* in the length of the head and of the metacarpal and fore-arm bones, and from *P. Meyeri*, which has a short head, a neck proportionally strong, with the fore-arm and metacarpal of equal length. The *P. Kochi* possesses an orbit proportionally small, with the bony circle composed of smooth plates; the dentition extends far back, the neck is short in proportion to the body, the metacarpal and the fourth phalanx of the long finger are of equal length, and the fore-arm is longer than the tibia. All these characters, and some others, are found in the specimen described by Dr. Winkler; but although all the parts are smaller than the typical form, they are only relatively so, and hence it is considered to be a young individual of the *P. Kochi*, Wagner.

In alluding to the small osseous piece which is seen in this specimen at the carpal end of the bone of the right fore-arm, Dr. Winkler reiterates the opinion which he had previously expressed in his description of *P. micronyx*, in the *Archives*, vol. iii. fasc. i., 1870, that this piece is an ossified tendon, with which Prof. Quenstedt agrees, and not a bone (Spannknochen) for extending the membrane, as thought by some of the German palæontologists who have studied the structure of Pterodactyles.

Another point of interest connected with this specimen is the alleged discovery by Dr. Winkler of undoubted traces on the stone of the membranous integument, the expansion of which was supported by the greatly elongated ulnar finger of the fore-limb, indications of which membrane had, however, been observed in a specimen of *P. crassipes*, described by Hermann von Meyer, which also forms a part of the Teyler Museum.

Dr. Winkler further remarks that, from an examination of the cast of a specimen of *Rhamphorhynchus*, from Eichstätt, purchased for Yale College, Massachusetts, the original possessed not only the membranes entire, but also the tail terminated by a kind of membranous expansion. J. M.

IV.—The Bengera Diamond Field. By A. LIVERSIDGE. 8vo. pp. 11. (Sydney, 1873.)

AN account of the discovery of diamonds in Australia is first given, and the nature of the Mudgee diamond-workings is pointed out. The diamonds occur in outliers of an old river-drift, which occurs at varying distances from the river, and at heights of 40 feet or so above it. These outliers are capped by beds of basalt, hard and compact, and in some cases columnar; the drift is chiefly made up of boulders and pebbles of quartz, jasper, agate, flinty-slate, shale, sandstone, with coarse sand and clay. The minerals associated with the diamond are enumerated. No diamonds have been found in the river-bed except in places where the diggers have discharged the drift into the river when washing for gold.

The Bengera district has many points of resemblance to that at Mudgee, the diamond-bearing deposits are situated in a kind of basin or closed valley, and running into the valley are various spurs of basalt which apparently cover portions of the drift. The relation of the basalt to the drift has however not yet been proved in the Bengera district, but should the drift pass under it, the known diamond-bearing area will be greatly increased. Up to the present time all the diamonds have been found within a foot or so of the surface, in fact just at the grass roots. In no case have the workings been carried to greater depths than two or three feet; in some parts examined the drift itself is not thicker than that. Mr. Liversidge describes in detail the mineralogical nature of the drift, or "wash-drift," as it is termed by the miners. The list of gems, stones, and other minerals accompanying the diamond includes the following:—Tourmaline, Zircon, Sapphire, Topaz, Garnet, Spinelle, Quartz, Brookite, Titaniferous iron, Magnetic iron-ore, Wood-tin, Gold, and Osmiridium. H. B. W.

REVIEWS.

I.—Geological Survey of Canada. Palæozoic Fossils. Vol. II. Part I. By E. Billings, F.G.S. (Montreal: August, 1874.)

THIS part, consisting of 144 pages of descriptive text, with numerous woodcuts and ten lithographed plates, contains descriptions (1) of fossils from the Silurian and Devonian rocks of Gaspé, (2) of new species from the Primordial rocks of Newfoundland, (3) of the genus and Canadian species of *Stricklandinia*, (4) of fossils from the Upper Silurian rocks of Arisaig, Nova Scotia, and (5) notes on the structure of the Crinoidea, Cystidea, and Blastoidea. The first section is preceded by a short geological notice of the Gaspé series of rocks, which comprise 7000 feet of Gaspé sandstones, with interstratified arenaceous and calcareous shales with plant-remains, underlain by 2000 feet of the Gaspé limestones with intercalated shales, these limestones being classed in descending order as Devonian, Passage-beds, and Upper Silurian. The fossils are chiefly Brachiopods and Lammellibranchs, with some few Gasteropods, mostly all obtained from the Upper or Devonian beds. The Primordial rocks of Newfoundland are estimated to have a thickness of about 6000 feet; the upper 500 feet, constituting Bell Island, hold a peculiar group of fossils, the exact age of which has not been determined; they consist of *Lingulæ*, Cruziana, and Fucoids, referred to the genus *Eophyton*, which in Sweden has only been found below the Paradoxides-beds. Below the Bell Island beds there are about 2000 feet of unfossiliferous strata, except Fucoids. These, with the Bell Island rocks, may represent the Middle and Upper Lingula-flags. They are immediately underlain by about 2000 feet of slates, sandstones, and limestones, holding fossils which prove them to be of the age of the Lower Lingula-flags or Menevian group of Salter and Hicks (p. 69). Fossils are abundant but imperfect, including *Agraulos*, *Paradoxides*, *Anopolenus*, with other Trilobites, and *Iphidea*, a new genus of Brachiopods.

Under the article on *Stricklandinia* the generic characters are considered and compared with Pentamerus, and six species noticed, two of which, *S. Salteri*, S. melissa, are new and from the Anticosti or

Llandovery group. The fossils of the Arisaig rocks (Upper Silurian) include descriptions of twenty new species, referred to *Orthonota*, *Goniophora*, *Grammysia*, and a new genus *Pteronitella*, differing in the arrangement of the hinge-structure from *Avicula* and *Pterinea*.

Many of the genera of the older Palæozoic bivalves require careful reconsideration, in order to establish more well-defined characters, and this Mr. Billings partly expresses as regards *Orthonota*, *Sanguinolites*, and *Goniophora*, which seem to be closely related to each other, so that references to these genera must be regarded as merely provisional.

The notes on the structure of the Crinoidea and allied families may be considered as the most important contribution to this volume, and although published in the American Journal of Science for 1869–70, and in the Annals of Natural History, 1870–71, are reproduced here as part of the Survey work. The subject is one to which Mr. Billings has given considerable attention, both in the Decades 1, 3, 4, of Canadian Organic Remains, 1858–9, and other publications. Considerable difference of opinion has arisen among palæontologists who have studied the subject, as to the position of the oral, anal, and ambulacral apertures in the Palæozoic Crinoids, Mr. Billings retaining the opinions he expressed three years ago, and are embodied in the present article without alteration, which comprises the position of the mouth in relation to the ambulacral system, the structure of *Codaster*, *Pentremites*, and *Nucleocrinus*, on the theory that the ambulacral and ovarian orifices are the oral apertures, and other points bearing on the question, to which are added some corrections and additions. In this section, after alluding to Prof. J. Muller's observations on the structure of the existing Crinoid, *Antedon Europæus*, Mr. Billings sums up:

> "It is said that the orifice, in the Cystidea and fossil Crinoids, which I believe to have been both oral and anal in function, is anatomically identical with the anus of existing Crinoids. If this be true, and if my theory is correct, it must follow that the Cystidea took in their food through the anus. The same phenomenon has been observed in an immature Star-fish. In the earlier stages of growth of *Asteracanthion berylinus*, Prof. A. Agassiz finds that there is, at first, only a single opening in the digestive sac. This opening is both mouth and anus. Afterwards a second opening is formed, which is the permanent mouth. The other opening thus becomes the anus. This Star-fish, therefore, in its embryonic stage takes in its nourishment through the anus. In this respect it is a Cystidean. I am informed the same arrangement occurs also in the Ophiurians and Echini. Granting, therefore, that the valvular orifice of the Cystidea is the anatomical homologue of the anal tube of a *Pentacrinus*, it does not follow it was exclusively anal in its function. I, however, do not admit it to be the homologue of the anus of *Pentacrinus*. I believe it to be the mouth. Mr. Billings further states that in the Echinodermata the position of the various organs, in relation to each other, and also to the general mass of the body, is subject to very great fluctuations. Thus, the mouth and vent are separated in some of the groups, but united in others; while either or both may open out to the surface directly upward, or downward, or at any lateral point. The ovaries may be either dorsal or ventral, internal or external, and associated with either the mouth, the anus, or with neither. The ambulacral skeleton may be imbedded into and form a portion of the general covering of the body, or lie upon the surface, or borne upon free moving arms.
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> "Again, (1) the aperture which, in an embryonic Echinoderm, is both mouth and anus, may in the mature stage become the anus only, a new mouth being *formed in another part of the body*. (2) It may become the permanent mouth,

and a separate anus be formed in another part. (3) The mouth may be, at first, situated out of the centre of the ambulacral canal system, and afterwards removed to it.

"I believe that the latter process took place in the development of the orders Cystidea and Crinoidea. In the first formed, or Palæozoic species, the mouth was not central, but has become so in the existing types." (pp. 91 and 127.)

These notes are valuable to the student of Palæozoic Echinodermata as embodying his own views, and those of other authors. The reader may refer also to Von Buch "On the Cystidea," translated by Prof. Ansted in the Quart. Journ. Geol. Soc. vol. ii., and to Prof. Beyrich, "On the Pelvis of the *Crinoidea brachiata*," translated by Mr. W. S. Dallas, and published in the Annals Nat. Hist. for June, 1871; also to the two valuable papers by Mr. John Rofe, C.E., F.G.S., in the GEOLOGICAL MAGAZINE, 1865, Vol. II. p. 12, and p. 245, Pl. VIII., in which the structure of the Crinoidea and Blastoidea is very fully treated.

J. M.

II.—THE SUB-WEALDEN EXPLORATION.

(SECOND NOTICE.)[1]

On a former occasion, when we gave an account of the Sub-Wealden Exploration, a depth of 671 feet had been reached. Since then, according to the Seventh Quarterly Report of Mr. Willett, dated June 23rd, 1874, a total depth of 1018 feet has been attained.

The fossils for the last 50 feet indicate that the Oxford Clay has been reached, thereby fulfilling (so Mr. Willett observes) the prophecy of the late lamented Professor John Phillips, who stated many months before that "very likely no Oolites or Sandy Rocks may be met with till we touch the unknown Palæozoics."

The following geological report is given by Mr. W. Topley, F.G.S., Assoc. Inst. C.E., of the Geological Survey of England:

"In the last Quarterly Report some particulars were given of the Kimmeridge Clay, as found in the Boring, down to the depth of 656 feet. With some few alterations, to be noted immediately, the description there given applies to the clay which has been pierced since.

"A beautiful specimen of *Ammonites Jason* occurred at about 990 feet. Neither this Ammonite nor any ornate form at all resembling it has yet been found in the Kimmeridge Clay. Such Ammonites, however, are amongst the most characteristic fossils of the Oxford Clay; we are, therefore, justified in concluding that the boring is now in that formation.

"Although the Coral Rag and Calcareous Grit usually lie between the Kimmeridge and Oxford Clays, there are certain localities in which they are absent. This is the case on the north and north-west of Aylesbury; in Lincolnshire; and probably also through the Fen districts. A deep well was sunk many years back at Lynn, in Norfolk; there the Kimmeridge Clay was found in direct sequence with the Oxford Clay.

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[1] For the First Notice, see GEOL. MAG. June, 1874, p. 281.

"From unavoidable causes, the lowest 200 feet of core have not yet been thoroughly examined. It is, therefore, possible that Oxford Clay fossils may hereafter be found at a higher level than that stated above. Very fine specimens of *Thracia depressa* occurred at 965 feet; this shell ranges through the Portland and Kimmeridge strata, being especially characteristic of the latter; it also occurs (but more rarely) in the Oxford Clay. *Gryphæa virgula* was found at 950 feet.

"We cannot hope, in so small a section, to establish any definite palæontological line between the Oxford and Kimmeridge Clays; if, indeed, any such line exist in this area. But the boring, small as it is, is quite sufficient to prove that there is not the slightest lithological break between the two formations.

"The clay throughout is more or less bituminous, some of the undoubted Oxford Clay being highly so. It is often sandy; sometimes it contains so much lime as to be almost a cement-stone. As a rule, oysters are more abundant in the sandy portions than elsewhere; the more calcareous parts are generally very bare of fossils."

The remainder of this notice is taken intact from Mr. Willett's own report.

"Most of us have been amused by the story of the traveller, who, having fallen over a precipice in the dark, and who having grasped, providentially, the branches of some shrubs growing from its face, with almost superhuman effort clung on for dear life, till appearing daylight showed him that he was but a few inches above the *terra firma* beneath his feet.

"The Palæozoic ridge of rocks which we are seeking was probably a submerged reef in the muddy waters which deposited the thick beds of clay we are now traversing. *We expect to come down suddenly upon it, and* IT MAY BE ONLY A FEW FEET BENEATH US! It may, however, be some hundred feet.

"Whatever be the distance, the chance of discovering its actual depth seems to be Now or Never.

"So vividly does this impress the minds of those who are most competent to judge, viz. Prof. Ramsay, Director-General of the Geological Survey of the United Kingdom; John Evans, Esq., F.R.S., the President of the Geological Society; Joseph Prestwich, Esq., F.R.S., past President of the Geological Society, and R. Godwin-Austen, Esq., F.R.S., V.P.G.S. (to which may be added the testimony of the late Professor John Phillips), that a new appeal for pecuniary aid has been prepared by them for circulation. It is manifestly unjust (even if it were practicable) that the small minority (in this intelligent and wealthy country) who have so liberally and at such sacrifices hitherto provided the means, should be further burdened, while there are, doubtless, ample sources of supply, hitherto untouched, which only need application to insure all that is necessary to complete our undertaking.

"It must not be forgotten, also, that this is an experiment specially recommended by a Parliamentary Committee (Coal Commission), and that we have also obtained the approbation of the President of *the Royal Society, of* the President of the Geological Society, and of the President of the Institute of Civil Engineers. If we were directly seeking for coal, the question would evidently be one for the adjoining landowners. If it were simply an ordinary scientific experiment, it might be left to those specially interested in the subject; but our object is to obtain information which, while it must certainly increase our scientific knowledge, may confer an incalculable benefit on large areas in which mineral wealth is at present an unknown quantity. None of our supporters have subscribed with the idea or intention of any personal gain whatever; and it is to minds thus constituted,—who will give 'hoping for nothing again,'—that we must look for help to finish our work.

"The Diamond Company have consented 'at less than half their published tariff' to endeavour to bore 200 feet more at £2 a foot, solely on the ground that it is a scientific, and not a commercial, undertaking. And, by the aid of their superior machinery and appliances, we have now a better prospect of boring 2,000 feet than we had of boring 1,000 under the old system."

III.—TRANSACTIONS OF THE GEOLOGICAL SOCIETY OF GLASGOW. Vol. IV. Part 3. 1874.

THIS part contains brief notices of the proceedings of the Society for the year 1872–3, with an account of the Conversazione held in December, 1872, at which a fine collection of geological specimens were exhibited by different members; abstracts of three papers, including the President's Address for 1874; and nine papers printed in full, most of which bear upon some interesting points of the geology and palæontology of the west of Scotland. Of the non-local papers, Mr. J. Geikie contributes a "Note on the Occurrence of Erratics at Higher Levels than the Rock Masses from which they have been derived," and considers an explanation of this curious problem may be eventually found in certain phenomena which have been observed in Alpine glaciers, such as stated by the late Prof. J. Forbes, "the tendency of glaciers to reject impurities, and the undoubted fact that stones are always found near or upon the surface of the ice." "It is enough to know," says Mr. Geikie, "that stones introduced into the body of a glacier, whether from above or below, tend to rise upwards in the ice, as the glacier flows on its way. Let us suppose a mountainous country, such as Scotland, covered with a wide ice-sheet, or series of confluent glaciers, and endeavour in imagination to follow the course of some hypothetical boulder which has been introduced by friction into the ice at the bottom of some valley in the interior of the country. As the ice creeps outwards, the stone gradually rises, the path which it follows sloping at a less angle than the bed over which the ice flows. Did no obstruction intervene, it is evident that the boulder, while it rose through the body of the ice, would be at the same time travelling gradually to lower levels than the point from which it originally set out. . . . But then we know that countless obstacles intervened to impede the flow of the massive ice-sheets of the Glacial ch; and with every such obstruction the glacier masses must have been forced to bulge upwards by the intense *vis a tergo;* and such upward movement of the ice, being again and again repeated, imprisoned boulders and *débris* would be compelled just as often to rise to higher and higher levels."

In the note by Mr. D. Robertson, "On the Precipitation of Clay in Fresh and Salt Water," it is shown there is a great difference between the two—fresh-water holding the clay in suspension for a considerable time; while water only slightly brackish has the power of precipitating it much more rapidly. "Keeping in view the large quantities of earthy matter annually carried down by rivers, a large proportion of which is precipitated as soon as it comes in contact with the water of the sea, we can easily understand how the courses of rivers, within the influence of the tide, diverge into various branches by the precipitated mud silting up the river-bed at one place, and the obstructed water forming a new channel at another; and hence throwing a new light on the formation of deltas at the mouths of rivers." The paper, "On the Geology of the North-Eastern District of Yorkshire," by Mr. T. M. Barr, is not, as the author justly states, anything like a systematic or exhaustive study of its geology, and is therefore only a general account of this valuable iron-ore bearing district. The "top seam," alluded to at page 298, does *not* belong to the *top* of the Upper Lias series, but belongs to the "Dogger" or Inferior Oolite, which is situated between the Upper Lias and the Great Sandrock above. This *seam* has been worked at Grosmont, and formerly in Glazedale. But it is in Rosedale, in the very centre of the great moorland district, that the Dogger and its associated beds have yielded the greatest results to mining enterprise. The celebrated Rosedale magnetic ore occurs as an enormous boss or local swelling in the Sandrock below the Dogger, about 600 yards long, by 150 feet wide, and 80 feet high. There is nothing like it in all this district, and it may fairly be described as the richest ore in North Yorkshire, a perfect nugget of iron-stone on a bare hill-side, 700 feet above the sea.[1]

Of the district papers, Messrs. Robertson and Crosskey continue their descriptions of the Post-Tertiary beds of the West of Scotland, which, when completed, will be of great value, for Mr. Robertson's intimate acquaintance with the estuarine and marine fauna of the Clyde, and his extensive collections (personally acquired) of recent British species, and those from the Post-Tertiary deposits, not only around the Clyde, but from Sweden, Norway, etc., will enable the authors to infer more clearly the conditions under which these strata were deposited.

Mr. J. Young contributes three papers: 1. "On the Probable Source of Certain Boulders in the Till of the Glasgow District," in which the origin of the Limestone blocks is chiefly treated. We trust this author will fully describe the fine section recently exposed at the extensive excavations for the Stobcross Docks, with its numerous and varied boulders, which could only have been brought together here from a wide extent of country lying in several different directions.

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[1] The Yorkshire Oolites. By W. H. Huddlestone, F.G.S. Proc. Geol. Asso., *1874, vol. iii. p. 305.*

2. "On the Occurrence of *Saccammina Carteri*, Brady, in the Lanarkshire Coal-field." This Carboniferous foraminifera, previously found in the Limestones of the N. of England and E. of Scotland, is interesting as being closely allied to a living species, *S. sphærica*, which appears to be common at great depths in the Atlantic. 3. In conjunction with Mr. J. Armstrong, a paper, "On the Fossils of the Carboniferous Strata of the West of Scotland."[1] This is the first of a series of papers (No. 1, Robroystone), which the authors intend to prepare, of the fossils found in each particular group of strata in the various localities where they occur, so as to compare them, and thus arrive at "a correct notion of the alternate change of condition under which the flora and fauna of the Carboniferous period existed."

More than 130 species are enumerated, chiefly Invertebrata, some of them new, and mostly obtained from a shale-bed associated with the Robroystone or Upper Limestone series. The Carboniferous shales of the West of Scotland appear to be very fossiliferous, which may be due to the abundance of life during their deposition, or to the greater facility with which the fossils weather out than in the associated harder limestones. We have been shown by Mr. Robert Craig, of Langside, a bed of shale about three feet thick, in his quarry, belonging to the Lower Limestone series, in which he has found 50 per cent. of the known fossils of the Beith district of Ayrshire.

In the last paper "On the Glaciation of the West of Scotland," Mr. D. Bell shows that the diverging striæ and trains of boulders in the neighbourhood of the Firth of Clyde must have been produced by a great sheet of land-ice, extending from the higher grounds, and entirely filling up the present estuary of the Clyde; while the branching Lochs, as Holy Loch, Loch Long, and Gare Loch, which form so striking a feature of the west coast, are simply old glacier channels, down which in various directions this great outflow of ice found its way from the frozen and snow-clad interior of the country; and he cites as evidence the numerous blocks of schistose, gneissose, and granitic rocks found along the eastern shore and to some height on the hill-sides above, in the vicinity of Greenock and Gourock, directly opposite the opening of the 'Lochs' above referred to.

We have noticed, in a recent visit to Gourock, the number of very large and small boulders of the rocks above mentioned along shore (as alluded to by Mr. Bell), from Kempoch Point to below the Cloch Light House, in a district consisting either of Old Red or Lower Carboniferous Sandstones and conglomerates, with intercalated and intrusive porphyry and trap rocks,—a district well worthy of careful examination for its interesting geological structure. Mr. Bell further states, that while the general glaciation of the Clyde valley is from W. to E. (or N.W. to S.E.), there have lately been observed instances of cross-striation, especially at Possil, where the N.W. striæ were considered to be the older, and the N.E. the newer of the two sets. This cross-striation is one of considerable interest to students of this department of geology.

J. M.

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[1] See the excellent general catalogue, by the same authors. Trans. Geol. Soc. of sgow, vol. iii. Supplement. 1871.

REPORTS AND PROCEEDINGS.

Geological Society of London.—November 4, 1874.—John Evans, Esq., F.R.S., President, in the Chair.—The following communication was read:—

"Notes on the Comparative Microscopic Rock-structure of some Ancient and Modern Volcanic Rocks." By J. Clifton Ward, Esq., F.G.S.

The author stated at the outset that his object was to compare the microscopic rock-structure of several groups of volcanic rocks, and in so doing to gain light, if possible, upon the original structure of some of the oldest members of that series. The first part of the paper comprised an abstract of what had been previously done in this subject.

The second part gave details of the microscopic structure of some few modern lavas, such as the Solfatara Trachyte, the Vesuvian lava-flows of 1631 and 1794, and a lava of the Alban Mount, near Rome. In the trachyte of the Solfatara, acicular crystals of felspar show a well-marked flow around the larger and first-formed crystals. In the Vesuvian and Albanian lavas leucite seems, in part at any rate, to take the place of the felspar of other lavas; and the majority of the leucite crystals seem to be somewhat imperfectly formed, as is the case with the small felspar prisms of the Solfatara rock. The order of crystallization of the component minerals was shown to be the following:—magnetite, felspar in large or small distinct crystals, augite, felspathic or leucitic solvent. Some of the first-formed crystals were broken and rendered imperfect before the viscid state of igneous fusion ceased. Even in such modern lava-flows as that of the Solfatara, considerable changes had taken place by alteration and the replacement of one mineral by another, and this very generally in successive layers corresponding to the crystal outlines. The frequent circular arrangement of the glass- and stone-cavities near the circumference of the minute leucite crystals in the lava of 1631 was thought to point to the fact that after the other minerals had separated from the leucitic solvent, the latter began to crystallize at numerous adjacent points; and as these points approached one another, solidification proceeded more rapidly, and these cavities were more generally imprisoned than at the earlier stages of crystallization. In the example of the lava of 1794, where the leucite crystals were further apart, this peculiar arrangement of cavities was almost unknown.

The third part of the paper dealt with the lavas and ashes of North Wales; and the author thought that the following points were established:—

1. Specimens of lava from the Arans, the Arenigs, and Snowdon and its neighbourhood, all have the same microscopic structure. 2. This structure presents a hazy or milky-looking base, with scattered particles of a light-green dichroic mineral (chlorite), and generally some porphyritically imbedded felspar crystals or fragments of such, both orthoclase and plagioclase. In polarized light,

on crossing the Nicols, the base breaks up into an irregular, coloured breccia, the colours changing to their complementaries on rotating either of the prisms. 3. Finely bedded ash, when *highly altered*, is in some cases undistinguishable in microscopic structure from undoubted felstone. 4. Ash of a coarser nature, when highly altered, is also very frequently not to be distinguished from felstone, though now and then the outlines of some of the fragments will reveal its true nature. 5. The fragments which make up the coarser ash-rocks seem generally to consist of felstone, containing both orthoclase and plagioclase crystals or fragments; but occasionally there occur pieces of a more crystalline nature, with minute acicular prisms and plagioclase felspar. 6. In many cases the only tests that can be applied to distinguish between highly-altered ash-rock and a felstone are the presence of a bedded or fragmentary appearance on *weathered* surfaces, and the gradual passage into less altered and unmistakable ash.

In the fourth division of his paper the author described some of the lavas and ashes of Cumberland of Lower Silurian age.

With regard to these ancient lavas the following was given as a general definition:—The rock is generally of some shade of blue or dark-green, generally weathering white round the edges, but to a very slight depth. It frequently assumes a tabular structure, the tabulæ being often curved, and breaks with a sharp conchoidal and flinty fracture. Silica 59–61 per cent. Matrix generally crystalline, containing crystals of labradorite or oligoclase, and orthoclase, porphyritically imbedded, round which the small crystalline needles seem frequently to have flowed; magnetite generally abundant, and augite tolerably so, though usually changed into a soft dark-green mineral; apatite and perhaps olivine as occasional constituents. *Occasionally* the crystalline base is partly obscured and a felsitic structure takes its place.

The Cumberland lavas were shown to resemble the Solfatara greystone in the frequent flow of the crystalline base, and the modern lavas generally in the order in which the various minerals crystallized out. In *external* structure they have, for the most part, much more of a felsitic than a basaltic appearance. In internal structure they have considerable analogies with the basalts. In chemical composition they are neither true basalts nor true felstones. In petrological structure they have much the general character of the modern Vesuvian lavas; the separate flows being usually of no great thickness, being slaggy, vesicular, or brecciated at top and bottom, and having often a considerable range, as if they had flowed in some cases for several miles from their point of eruption. Their general microscopic appearance is also very different from that of such old basalts as those of South Stafford and some of those of Carboniferous age in Scotland.

On the whole, while believing that in *some* cases the lavas in question were true basalts, the author was inclined to regard most [illegible] as occupying an intermediate place between felsitic [illegible] lavas; and as the felstone-lavas were once probably trachytes, these old Cumbrian rocks might perhaps be called Felsidolerites, answering in position to the modern Trachy-dolerites.

A detailed examination of Cumbrian ash-rocks had convinced the author that in many cases most intense metamorphism had taken place, that the finer ashy material had been partially melted down, and a kind of streaky flow caused around the larger fragments. There was every transition from an ash-rock in which a bedded or fragmentary structure was clearly visible, to an exceedingly close and flinty felstone-like rock, undistinguishable in hand specimens from a true contemporaneous trap. Such altered rocks were, however, quite distinct in microscopic structure from the undoubted lava-flows of the same district, and often distinct also from the Welsh felstones, although *some* were almost identical microscopically with the highly-altered ashes of Wales, and together with them resembled the felstone-lavas of the same country.

This metamorphism among the Cumbrian rocks increases in amount as the great granitic centres are approached; and it was believed by the author that it took place mainly at the commencement of the Old Red period, when the rocks in question must have been buried many thousands of feet deep beneath the Upper Silurian strata, and when probably the Eskdale granite was formed, perhaps partly by the extreme metamorphism of the volcanic series during upheaval and contortion. The author stated his belief that the Cumbrian volcanos were mainly subaerial, since some 12,000 feet of ash- and lava-beds had been accumulated without any admixture of ordinary sedimentary material, except quite at the base, containing scarcely any *conglomeratic* beds, and destitute of fossils. He believed also that *one* of the chief volcanic centres of the district had been the present site of Keswick, the low craggy hill called Castle Head representing the denuded stump or plug of an old volcano.

The author believed that one other truth of no slight importance might be gathered from these investigations, viz. that neither the careful inspection of hand-specimens, nor the microscopic examination of thin slices, would in *all* cases enable truthful results to be arrived at, in discriminating between trap and altered ash-rocks; but these methods and that of chemical analysis must be accompanied by oftentimes a laborious and detailed survey of the rocks in the open country, the various beds being traced out one by one and their weathered surfaces particularly noticed.

DISCUSSION.—Mr. Frank Rutley stated that he had examined many of the microscopic sections upon which much of the author's evidence was based, and he believed that Mr. Ward was, in the main, correct in his conclusion that many of the rocks designated trap were intermediate between dolerite and felstone, for sections from one end of the series presented the character of true basalt, while others from the opposite end appeared under the microscope to be true felstone; a variety of sections having also been cursorily examined which passed by almost imperceptible gradations from the dolerites to the felstones. He considered that Mr. Ward had done as much in the determination of these rocks as it was possible to do by the examination of merely ready-mounted sections; although, from this method of investigation having been the only one at the author's disposal while working in the field, he thought that the evidence regarding some of the component *minerals* was scarcely satisfactory; and he adverted to the importance of examining sections of rocks by other tests than that of mere microscopic scrutiny prior to the final mounting of the preparations. He was inclined to regard some of the ashes, of which sections were exhibited, as volcanic ejectamenta, imbedded in a base much resembling devitrified, or partially devitrified matter allied to pitchstone; and he could not agree with the author in regarding the fluxed character of this base as a structure superinduced by metamorphism, at all events not in the restricted sense of that term.

Mr. Koch thought that the flow of materials around crystals may be due to secondary actions. The effects of tension applied to molten matter may produce appearances similar to those described by the author. The study of the optical properties of crystals produced under tension would, he considered, materially assist in the determination of the nature of the crystals in rock-masses. He regarded chemical analysis as not furnishing a sufficient test.

Mr. Forbes remarked that too much stress should not be laid upon the apparent order in which the constituents in a lava had crystallized or solidified, as it had been experimentally proved that this order was not necessarily that of their fusing-points, and cited as an example to be seen every day on the large scale, the Pattinson's process for desilverizing lead, in which the lead is seen to solidify in crystals at a temperature at which the infinitely less fusible silver remains fluid. As a rule he had not found any difficulty in distinguishing under the microscope between a normal lava and one which had become reconsolidated from its ash or tuff, and protested against the very frequent application of the term Volcanic Ash to beds which were true volcanic tuffs. In answer to the question as to what was the difference between ashes and tuffs, he defined ashes as purely subaerial formations, thrown out of the volcanic orifice, and falling down on to land or sea as the case happened; whilst tuffs, on the contrary, were molten lava poured out into or more often under water, and thus instantaneously quenched and disintegrated into fragments or powder more or less fine in proportion as the action of the water was overpowering. In ashes each separate particle bore on its exterior the evidence of its having been exposed to the action of fire in the throat of the volcano, and externally is altered, glazed, or coated with a crust or skin, often resembling that of a meteorite, an appearance which is never to be observed in tuffs.

Prof. Ramsay said that he thought Mr. Ward was on the right track, and that the microscopic study of rocks must lead to most valuable results. He rejoiced to find that the determination of the nature of the rocks of the Welsh district, made by the Geological Survey some thirty years ago, was now confirmed by microscopical research. This seemed to show that the larger features of a district might be worked out without the aid of a microscope. He stated that his conclusion was that the ashes had been thrown out of old Silurian volcanos, first beneath the surface of the sea, and afterwards above water as the vents increased in height. The green-slates were fine ashes thrown out upon land.

Mr. Bonney stated that he had recently examined the "Green Slates and Porphyries" series, and wished to bear testimony to the value of Mr. Ward's researches, and the great difficulty of determining some of the metamorphosed rocks. There was, however, no doubt that the latter, notwithstanding the extent to which, through metamorphism, they simulated the appearance of igneous rocks, were originally stratified volcanic ashes or tuffs. He had not yet been able to examine his own specimens microscopically, but so far as he could determine without that, he should class some as diabase, others as "porphyrite." He called attention to the remarkable lithological correspondence between the "Green Slate" series of the Lake District and the so-called Cambrian of Charnwood Forest, the volcanic breccias, ashes or tuffs, and hornstones of both being often very similar. It was remarkable that the strike of these "Green Slates," when last seen to the S.E., was about W.N.W., which corresponded nearly with the Charnwood strike. Hence he thought it possible that they might be of the same age.

Mr. Judd remarked that the circumstances connected with the mode of occurrence of certain very important rock-constituents, such as leucite, haüyne, nosean, mellilite, etc., seemed to point to the conclusion that species of minerals may present peculiarities of distribution, both in space and time, analogous to those of *animal* and vegetable species. He suggested the necessity of constantly keeping *in view* such a possibility when making comparisons between ancient and modern olcanic rocks.

Mr. Blanford inquired whether the ancient traps are not distinct in their origin from true lavas. In India large districts are formed of volcanic rocks much more recent than those of Wales, and probably of different composition. These Indian flows are of great horizontal extent, but of small thickness.

Mr. Forbes stated that the Indian rocks in question, which he had examined, were not distinct from our basalts in composition and structure, which showed that they were not poured out under water.

Mr. Ward replied as follows :—To Mr. Rutley; that the *flow* described as occurring in some of the altered ash-rocks was *not* a decided crystalline flow, but one merely of the finer ashy material around the larger fragments, and frequently along the bedding planes. To Mr. Forbes and Mr. Koch; that the analyses brought forward had been made from specimens carefully collected in the field, and might be considered as representing the average chemical composition; the author used the word *ash* as denoting all material shot out from a volcano; in this case the ashes were mostly subaerial. To Mr. Bonney; that although the analyses of the Cumberland lavas were very similar to those of porphyrites, the microscopic structure of the latter, as described by Zirkel, did not at all correspond with that of the Lake-district rocks. To Mr. Blanford; that the Cumberland contemporaneous traps were as much entitled to the name of lavas as any modern Vesuvian flow.

CORRESPONDENCE.

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GLACIATION IN WEST SOMERSET.

Sir,—A few days ago, while waiting for a train at Taunton station, I took the opportunity of examining some of the specimens of glaciated sandstone, described by Mr. Lucy, in the Geological Magazine for June, page 256, and which he has deposited in the Museum of the Somersetshire Archæological Society. The appearances presented by them are certainly unlike any form of striation save that attributed to glacial action. My reason, however, for writing this is merely to note what Mr. Lucy has omitted to explain, and that is, that the rock striated is not the New Red Sandstone, which does occur near Porlock, but the so-called Devonian sandstone, and which is, as the late Mr. Jukes considered, identical with true Old Red Sandstone. Horace B. Woodward.

Newton Abbot, *2nd Oct.*, 1874.

EXISTENCE OF CARBONIFEROUS ROCKS IN THE HIGHLANDS OF SCOTLAND.

Sir,—It will probably interest many of the readers of the Geological Magazine, to be informed that rocks of Carboniferous age exist in the *northern* side of the great Grampian axis of the Highlands. While engaged in prosecuting my studies among the Secondary Rocks of Scotland, during the past summer, I found, in the district of Morven, a very interesting patch of strata of sandstone, shale, and coal, yielding the remains of a number of common Carboniferous plants. The true character of these plant-remains was confirmed by an examination of some of the specimens, which Sir Charles Bunbury was so kind as to make.

Although this patch of rocks, occurring in so unexpected a locality, is of very small extent, yet it is of very great interest to geologists, for the following reasons.

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